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INSTRUMENTS and AUTOMATION

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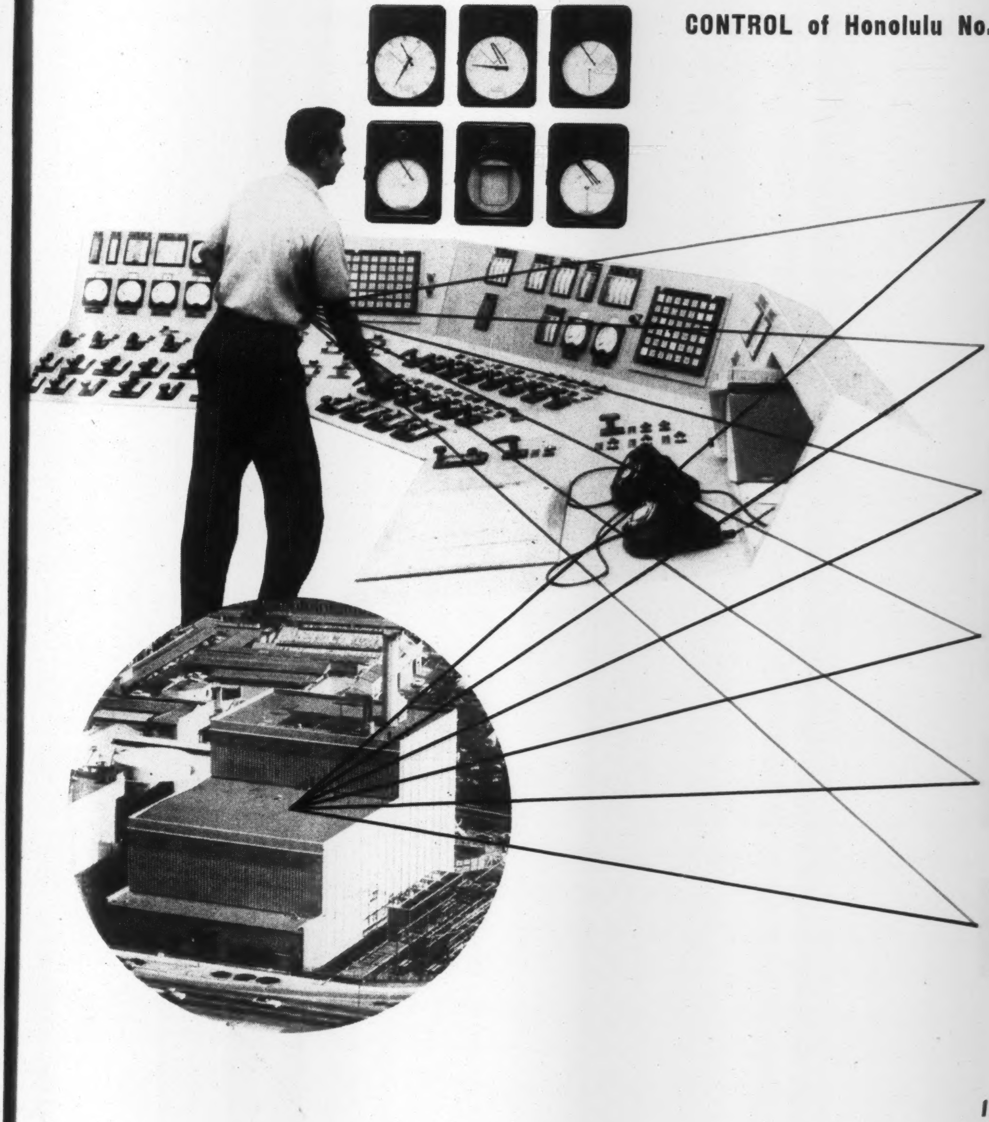
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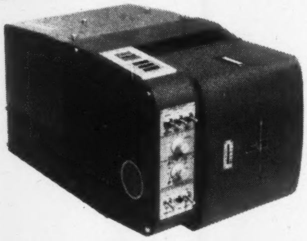
Instrument Manufacturing
The Journal of the SCMA
Simulation Council Newsletter

JUNE 1956

A MIDWESTERN OSCILLOGRAPH for every recording application



This tabulation shows the many types of MIDWESTERN recording oscillographs available today.

SPECS

Model	Maximum Trace Capacity (1)	Dimensions Inches (2)	Weight Pounds (3)	Record Speed Range Inches/Sec	Record Width Inches	Magazine Capacity Feet (5)	Power Requirements	Timing Lines Sec/Line	Optical Arm Inches	Temperature Range °F	Maximum Acceleration G's	Model
560	14	5¾ x 6⅝ x 7 1/16	9	.375 To 8	3.625	50	28 Volts d.c. 3 Amps Max.	—	6.921	0 to + 160	20 (8)	560
580		7⅝ x 7⅞ x 13½	22.5	.50 To 44.75 (4)		100	28 Volts d.c. 15 Amps Max.	.01 And/Or .10	7.375	—65 to + 190	20	580
581		7⅝ x 7⅞ x 15⅜	28.5									581
544	36	11½ x 12⅞ x 20	75	1 To 50	8	200	28 Volts d.c. 10 Amps Max. or 115 Volts, 60 cps 3 Amps Max.		14.469	+ 32 to + 160	1	544
570	50	11½ x 16⅞ x 20	97		12							570
590	36	11 x 11⅝ x 21⅞	90	.082 To 129.9	7	150	(6)	(7)	11.00	—65 to + 160	15	590
591	50	11 1/16 x 16 13/16 x 24¾	130		12	250						591

FEATURES

Model	Record Numbering	Trace Identification	Automatic Record Length	Timing Line Intensity Control	Galvo Lamp Intensity Control	Record Used Indicator	Recording Malfunction Indicator	Galvo Lamp Burnout Indicator	Timing Lamp Burnout Indicator	Rotary Scanning	Remote Control	Model
560	—	—	—	—	√	—	—	—	—	—	—	560
580	—	√	—	√	√	√	—	√	√	—	√	580
581	√	√	√	√	√	√	√	√	√	—	√	581
544	√	√	√	(9)	√	√	√	√	(9)	√	√	544
570	√	√	√		√	√	√	√		√	√	570
590	√	√	√		√	√	√	√		√	√	590
591	√	√	√		√	√	√	√		√	√	591

NOTES
(1) Using MIDWESTERN 102 Galvanometers.
(2) Dimensions include all external controls and fittings but do not include mating electrical connectors or shock-mount base.
(3) Weight does not include shock-mount base.
(4) A low speed version of these models is available with all recording speeds reduced by a factor of 60.
(5) Listed magazine capacities are with Kodak Linagraph #809 Paper. Other standard recording paper or film may also be used. Larger capacity magazines are available for the 580, 581, 590, and 591 Models.
(6) May be operated from 28 volts dc, 15 amps max.; or 115 volts, 60 or 400 cps single phase, 5 amps max. by means of interchangeable plug-in power supply units.
(7) Timing lines of .001 and/or .01; .01 and/or .10; or .10 and/or 1.0 seconds intervals, by means of interchangeable plug-in units.
(8) A special version of this model is available which will withstand shock accelerations in excess of 1000 gravities.
(9) Timing lines are produced by electronic flasher-tubes. Due to their much longer operating life, warning indicators are not required; and because of their flash illumination characteristic, intensity adjustments are not necessary.

for complete details on the above oscillographs — and other MIDWESTERN test recording instruments and servo components — write

MIDWESTERN INSTRUMENTS

41st and Sheridan Road • Tulsa, Oklahoma

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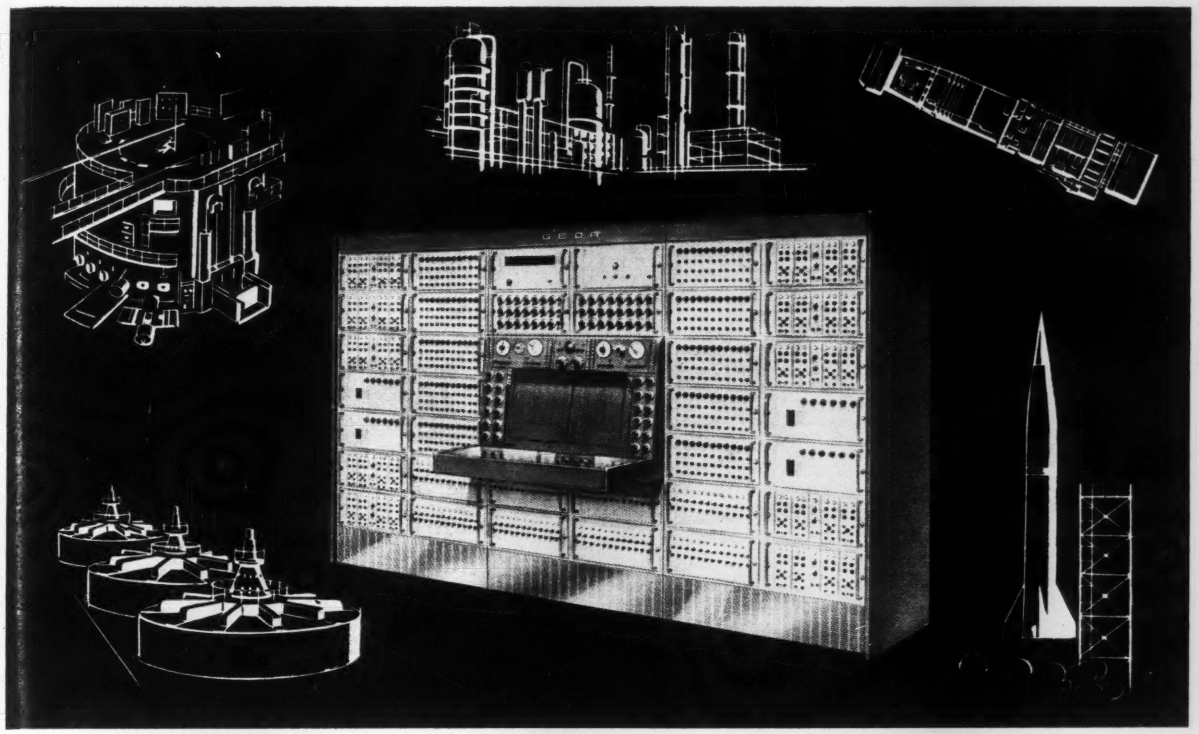

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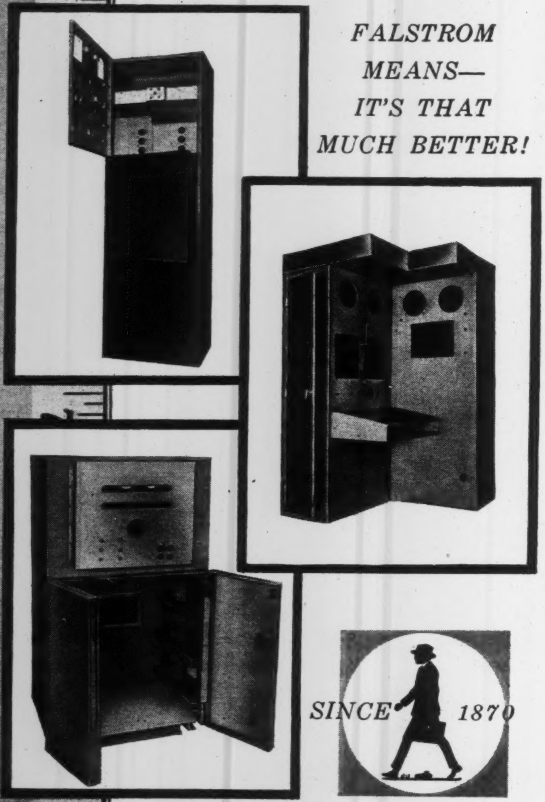

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Volume 29, No. 6
June 1956

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Even though the new General Electric PM-20 general-purpose oscillograph has many features not found on comparable oscillographs, it is priced at only $4,200* net.

A WIDE RANGE of frequencies—from d.c. to 6,000 cps—can be recorded at speeds from 0.8 to 100 inches/sec with the new oscillograph.

AUTOMATIC RECORD NUMBERING, timing lines, trace interruption for identification, and automatic record-length control are a few of the many additional features provided for convenient operation.

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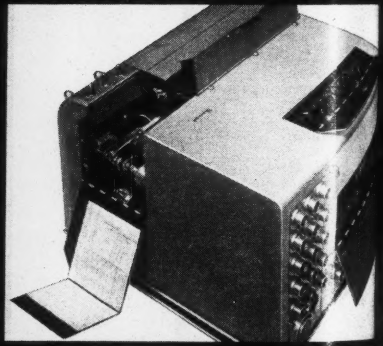
PM-20 OSCILLOGRAPH



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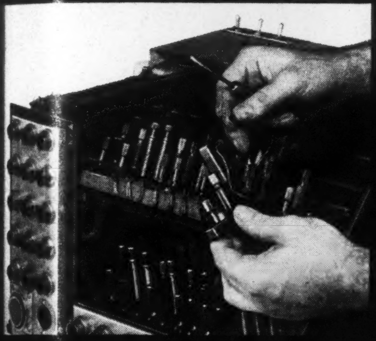

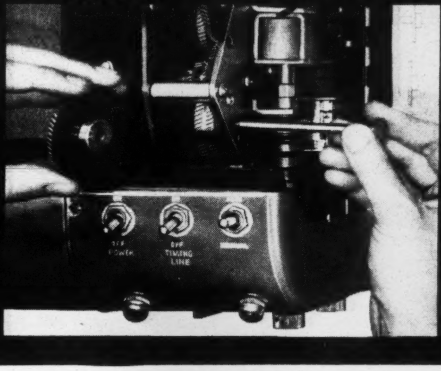

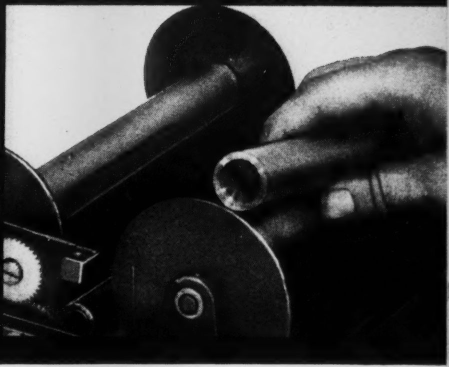

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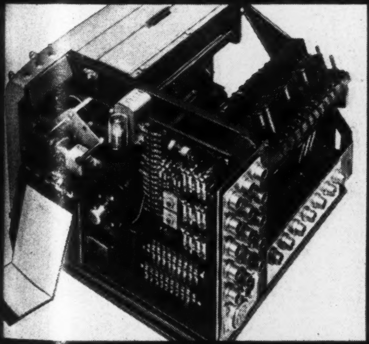

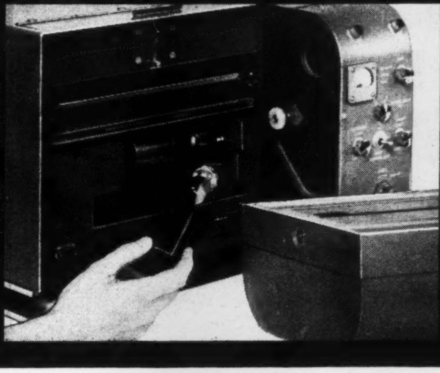

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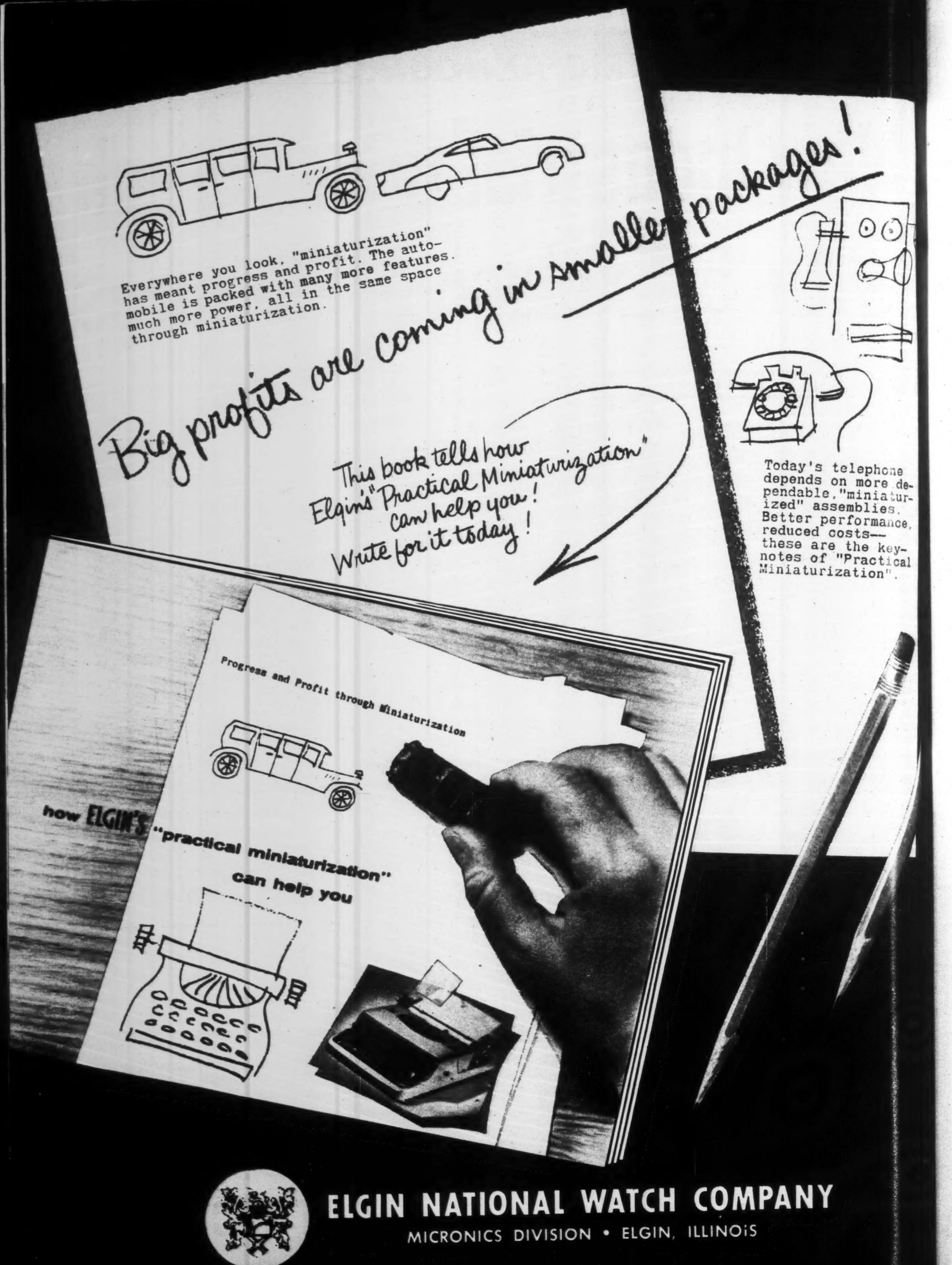

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Letters to the editor

Editor, I&A:

It is interesting to note the recognition you accord to the subject of control valve terminology by publishing in your May issue the "Terminology for Power-Actuated Valves" recommended by the Fluid Controls Institute and an abstract of ASME Paper No. 55-A-91, "Terminology of Control Valves" by Messrs. Washburn and Milham. These separate presentations of similar subject matter suggest the desirability of further steps to reach common agreement in this particular area of technical language. Accordingly I believe your readers will be interested to know that the Terminology Committee of the Instruments and Regulators Division of ASME has set up a Subcommittee on Control Valve Terminology, which is actively working to complete the project initiated by the classification and definitions proposed in the Washburn and Milham paper. We shall appreciate mention of this fact in your next issue.

Suggestions and comments related to this undertaking will be welcomed by the Chairman of the Subcommittee on Control Valve Terminology, Mr. C. R. Otto, E. I. duPont de Nemours & Co., Wilmington 98, Delaware, or by the writer.

E. S. Bristol, Chm.,
Terminology Committee
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4901 *Stenton Ave.*
Philadelphia 44, *Pa.*

Editor, I&A:

Your Biography on Axel H. Peterson and his comments that "the research scientist needs to spend more money on instruments that are already developed" and that "*I&A* does a superb job in reporting available commercial instruments" are statements with which I agree 100%.

Along the line of "commercial instruments" I would like to bring up a subject for the industry to consider. Many instrument manufacturers have designed their major items for use as a separate unit or for installation in standard 19″ racks. This is excellent except for the numerous small instruments that are too small to design into the 19″ width or not practical for other reasons. These small instruments make it difficult to use the 19″ rack method for mounting instruments for test purposes.

I suggest the industry consider the adoption of "standard" sizes for these small instruments so they can be used as a separate instrument or mounted on "special" 19″ panels by some simple means.

We have attempted to correct this condition here in the Test Instrumentation group as it pertains to instrumentation units we design, by selecting 3 standard front panel sizes. These sizes are 5″ wide x 6″ high, 8″ wide x 7″ high, and 8″ wide x 11″ high. The smallest mounts behind an opening 4½″ x 5½″, in a 19″ x 7″ panel, 3 units per panel. The second size mounts behind 7½″ x 6½″ openings in a 19″ x 8¾″ panel, 2 units per panel. The large size mounts behind 7¼″ x 10¼″ openings in 19″ x 12¼″ panel, 2 units per panel.

These instruments can be used as individual instruments on small tests requiring only a few instruments or, by removing four screws, can be mounted on panels for rack mounting for tests requiring many instruments. The small panel openings are used also for meter mounting with adapters. This provides a very flexible "building block" method for instrumentation.

I would like to hear what the industry has to say about the possibility of "standardizing" small instrument sizes along lines as mentioned above.

Harry G. Bangerter
Test Group Instrumentation
Douglas Aircraft Co.
Long Beach, Calif.

Editor, I&A:

Your recent editorial report of SAMA's position on House Bill H.R. 6381 is deeply appreciated by all members of the Scientific Instrument Industry.

Since the members of the industry all feel very deeply about the ultimate passage of this highly significant piece of legislation, your editorial

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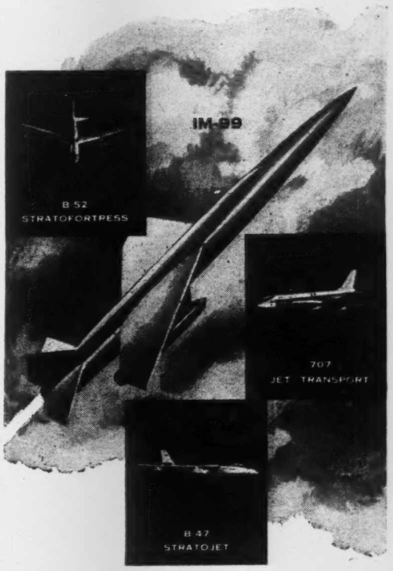

Statham unbonded strain gage liquid rotor angular accelerometers offer a simple, reliable means for the study of the rotary motion of a test body under conditions where a fixed mechanical reference is not available. For static and dynamic measurements in ranges from ±1.5 to ±3,000 rad/sec^2, four standard models are offered.

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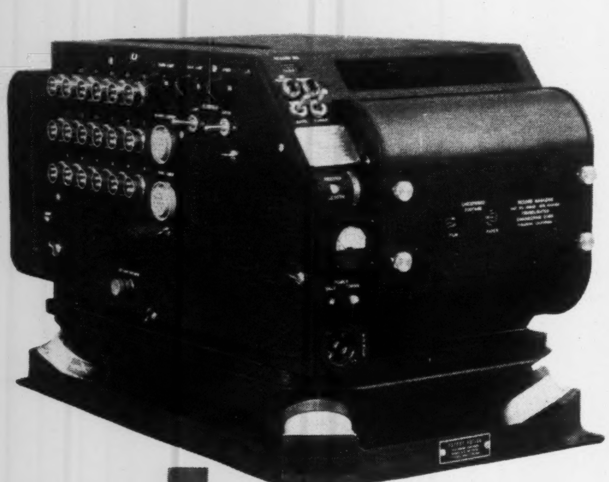
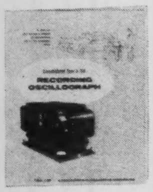
The 5-114 has crashed in test planes, yet yielded intact records, accurate up to the very moment of impact. Data in such cases have been invaluable in tracking down the cause of failure and in redesigning the aircraft. (And the oscillographs have *still* been good for years of additional flight-test service!) For the story of the world's favorite oscillograph, write today for Bulletin CEC 1500C-X7.





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LETTERS—CONTINUED

reiteration of our position is certainly timely and in the interest of all concerned with maintaining the usual high quality of our industry's products.

Hence, H.R. 6381, which provides for crediting certification fees to the account of the National Bureau of Standards rather than the general fund of the Treasury, is worthy of support by all of us who realize its significance and many implications to the technological progress of our country.

James R. Irving
Director of Public Information
Scientific Apparatus
Makers Association
Chicago 6, Illinois

These implications are greater than commonly appreciated. Under present law, the more standards supplied to industry by the NBS, the less money the Bureau has left with which to operate. This situation is not healthy or conducive to better service to industry in the supply of standards, a sine qua non in instrumentation. We repeat: All you instrument users and manufacturers, having been informed of this situation, should send a post card or telegram to your Congressman and/or J. Percy Priest, Chairman, House Interstate and Foreign Service Committee, registering your interest in support of House Bill H.R. 6381. The issue is in your hands, citizens.

Editor, I&A:

Please bill me for the five renewals to *Instruments and Automation* included on the enclosed card. We men in radar systems at Hughes Aircraft have found your publication very informative, and it has become an important tool in our Test Engineering Dept.

R. E. Stout
Hughes Aircraft Co.
El Segundo, Calif.

Of course, every subscription is a compliment to I&A, but we appreciate the consideration of men who take an extra moment of their busy time to tell us of their appreciation.

Editor, I&A:

Some time ago I sent for a copy of Aronson's *Computer Handbook*, First Edition. As of this date, it has not arrived and I suspect the demand far exceeds the supply.

Now here's my problem. I'd like to beg, borrow, or steal—even purchase a copy, if one were available

My brief review of a colleague's jealously guarded copy has convinced me that it is an indispensable reference for the initiated and a sophisticated primer for the rest of us.

Donald W. Conovar
Human Engineering Section
Convair, Div.
General Dynamics Corp.
San Diego, Calif.

Your Handbook is on its way, Donald.

Editor, I&A:

I am a manufacturers' representative for automatic control equipment, and, acting upon a reference received from you, I have been appointed area representative for a well-known firm. I wish to express my thanks to you for referring my name to this firm.

My name has been in your files for a few years, and I have observed that over this period the highest quality of inquiries concerning representation can be traced to references from your office. I am much impressed by the effectiveness of your listing service, which is very much in keeping with the general business-like manner in which you people conduct all of your operations.

John Meyer
Buffalo, N. Y.

The service referred to is one we offer free of charge to instrument manufacturers seeking area representatives. We have the most complete file of such representatives in the instrument industry.

Editor, I&A:

May I indicate my appreciation of the writings of your Mr's. Klein, Williams and Morgan. More of the same, PLEASE.

Robert C. Raymond
Purchasing and Promotion
WillowCrest Commercial Pottery
Claremont, N. H.

Yes Sir . . . see pages 1109-1117. To all who wish copies of this entire series, send in your names. We will notify you when the entire series is available in book form.

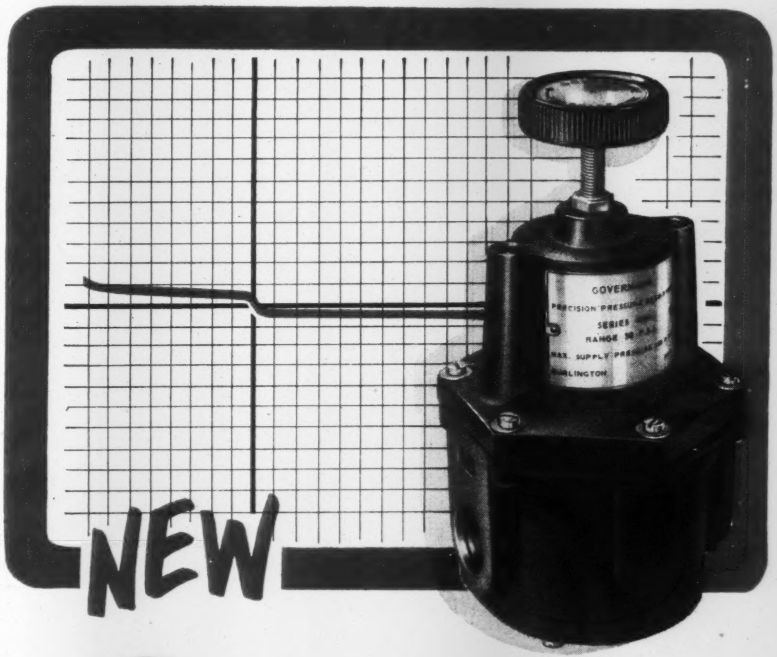
Editor, I&A:

I do not mean to dispute your statement that "Automation is the substitution of mechanical, hydraulic, pneumatic, electrical and electrical devices for human organs of observation, decision and effort."

Yet, there is something missing.

Continued on page 1052

ONLY ONE REGULATOR PROVIDES PNEUMATIC CONTROL LIKE THIS!



Governaire
ZERO | ZONE

PRECISION PRESSURE REGULATORS

"Governaire" is the name of an entirely new design and achievement in precision controls for pneumatic loading. They differ from ordinary, existing instruments in their superior accuracy, greater reliability, improved immunity to variations in supply pressure and ability to fill or exhaust a remote volume far more rapidly. Typical flow curve shown above (Series 4000) graphically illustrates Governaire's minimum pressure offset effect as *Zero-Zone* is passed.

Typical specifications of the Series 4000 Regulator include five ranges (10, 30, 60, 150 and 250 psi); high capacity ⅝" diameter supply and exhaust seats (no other regulator of equal pipe size has even a *supply* capacity equal to the Series 4000 *exhaust* capacity); three sizes (⅜", ½" and ¾" NPT with two ¼" gauge taps). The Series is especially suited to such machine applications as welding head pressure control, punch press brake and clutch control, cable and sheet tensioning devices, etc.

Series 4000 is one of eight Governaire precision control devices now in production and available for delivery. Descriptive information and performance data on any will be sent on request. Write, outlining your application.

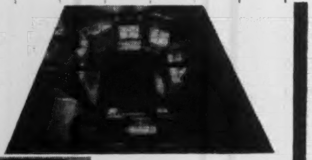
Governaire
DIVISION OF BELLOFRAM CORPORATION
BURLINGTON, MASSACHUSETTS

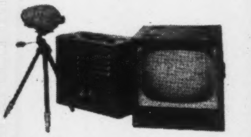
For more information circle 9 on inquiry card.

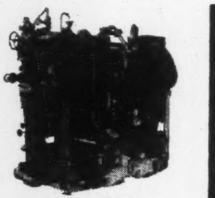
● Manufacturing ●● Manufacturing and product development ●●● Manufacturing, product development and research □●● Pilot manufacturing, product development and research

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	GPE CAPACITIES
●●●	●●	●●	□●●	●●	●●●		●●	●●●	●●	●●	●●	●●●	Precision Mechanics, Optical Devices, Ceramics
●●●	●	●			●●●		●●●	●●	●	●●	●	●●●	Electrical Equipment and Components
●●●	●●	●●●	●●●		●●●		●	●●		●●●	●●	●●●	Electronics
	●●			●●●		●●●				●●●			Hydraulics, Liquids Processing, Heat Exchange
●	●		●●●		●					●			Television: Studio, Theatre, Business, Institutional, Industrial
●●●	●	●●	□●●		●●●	●●●	●●	●●		●●●	●	●●●	Instruments, Servos, Controls: Hydraulic, Pneumatic, Magnetic, Electronic
●●●	●		●●●		●●●		●			●●	●	●●●	Aircraft and Missile Guidance, Control, Simulation
●●●	●	●	□●●		●●●					●●●		●●●	Automatic Computers and Components
●●●	●	●●	●●●		●●			●		●			Radar, Microwave, Ultrasonics
	●●●		□●●				●●	●●●	●●●		●●●		Motion Picture and Audio Equipment
●●●				●●						●●		●●●	Nuclear Power Components and Controls
●●●			●●●	●●●	●●●	●●●				●●●		●●●	SYSTEMS ENGINEERING

Librascope Desk-Size Computer


Link Aviation F-89D Jet Simulator


GPL Industrial-Institutional TV System


Griscom-Russell Shipboard Distilling Plant

Askania Electro-Jet Power Package

SYSTEMS ENGINEERING

The GPE Companies are leaders in that small, select group in American industry which is broadly qualified to develop and produce the systems needed today for defense and industry. GPE leadership accounts for some of the most advanced systems in use in business, television, aviation, marine, steel, oil, and other industrial fields.

In Systems Engineering, highly advanced capacities and resources are prerequisite. Yet, no matter how highly advanced, they are of little use if limited to a few areas. Finding optimum solutions to complex systems problems calls for *balanced competences*. And beyond that, success calls for the consistent application of such competences *at every stage* — beginning with research, and extending all the way through development, production and final testing.

No GPE company is limited by the boundaries of its own specialties. The basic GPE operating policy, GPE Coordinated Precision Technology, places at the command of each company in the group all GPE research, development and production facilities, and the skills and experience of the more than 2,500 GPE technical men working in depth in the wide range of advanced capacities indicated in the chart above.

Behind each group working on a specific problem in one GPE company stands the whole group of GPE scientists, engineers and technicians with the answers — or the knowledge that will find the answers — to questions underlying and related to that problem. To the customers of GPE Companies this means that the concept and development of equipment, components and systems are not restricted or distorted by traditional allegiance to specific competences.

The five systems illustrated, while products of different GPE companies, are all examples of the consistent application of balanced competences, achieved through GPE coordination. For brochure describing GPE Coordinated Precision Technology and the work of the GPE Companies, or help on a specific problem, write: General Precision Equipment Corporation, 92 Gold Street, New York 38, N. Y.

GENERAL PRECISION EQUIPMENT CORPORATION

THE GPE PRODUCING COMPANIES	
I KEARFOTT COMPANY, INC.	II INTERNATIONAL PROJECTOR CORPORATION
III BLUDWORTH MARINE	IV GENERAL PRECISION LABORATORY INCORPORATED
V THE GRISCOM-RUSSELL COMPANY	VI LINK AVIATION, INC.
VII SHAND AND JURS CO.	VIII THE HERTNER ELECTRIC COMPANY
IX THE STRONG ELECTRIC CORPORATION	X J. E. McAULEY MFG. CO.
XI ASKANIA REGULATOR COMPANY	XII AMPRO CORPORATION
XIII LIBRASCOPE, INCORPORATED	

For more information circle **10** on inquiry card.

GPL *ii-TV* camera with remote control of iris aperture and lens optical focus. Vernier control of focus regardless of lens focal length. Nylon gear drives give quiet, positive action; local control of camera also available.

Mounted for indoor use with remote control of pan and tilt, GPL *ii-TV* camera provides 360° camera viewing and 90° tilt. Position accurately indicated on control box.

Outdoor unit; weatherproof under all conditions; permits full 360° camera viewing, 90° tilt. Heavy-duty remote pan and tilt unit equipped with solenoid brakes to prevent drift, regardless of wind velocity.

Complete Remote Control with GPL *ii-TV*®

GPL's *industrial-institutional* closed-circuit TV system

There's *ii-TV* closed-circuit equipment to fit every industrial "seeing" problem. And GPL's skilled application engineers will be glad to help you select the system best suited to your need.

GPL *ii-TV* is designed, built and engineered by men who have the highly specialized skills required to produce top quality equipment. Every piece in the *ii-TV* System reflects GPL's extensive experience in the production of high performance television systems to meet the rigid standards of the Armed Services and broadcasting studios.

Investigate the bright, clear picture, rugged construction, dependability and all-around economy of the outstanding GPL *ii-TV* System. Compare—and you'll see that nothing is more economical than the best.

Dangerous processes of any kind can be closely controlled in complete safety with GPL *ii-TV*. System's remote control features are equally effective in countless other industrial applications.

For further information, or application engineering assistance, write or contact:

General Precision Laboratory Incorporated
Pleasantville, New York

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

For more information circle **11** on inquiry card.

AIRBORNE COMPONENTS
IN MINIATURE

Kearfott
3" VERTICAL GYRO

SHOWN 1/4 SIZE

GYROS

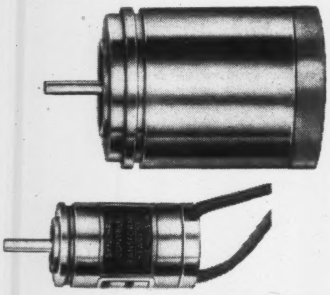
Kearfott 3" Vertical Gyro measures only 3"x3"x4" and weighs 3 pounds. It offers the same accuracy and dependability as its predecessor, three times its volume and weight.

CHARACTERISTICS

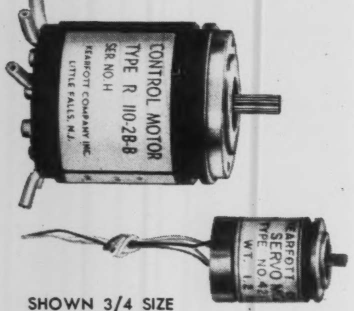
2 degrees of freedom, accuracy 15 minutes max. of ½ cone angle, and erection rate 3°/minute — normal. Erection time — 30 secs max. from any position

SYNCHROS

Kearfott (Penny Size) Synchros offer a reduction in diameter from 1.5 inches to .75 inches and in weight, from 5 oz. to 1.75 oz. In spite of this reduction, accuracy has been improved from 15 minutes to 10 minutes max. error from EZ. *Available as transmitters, control transformers, resolvers and differentials.*



SHOWN 3/4 SIZE



SHOWN 3/4 SIZE

SERVO MOTORS

Kearfott (Penny Size) Servo Motors measure only .750 inches diam. x .980 inches and weigh 1.2 oz. They are ideal for instrument servo applications because of their high torque-to-inertia ratio and small size and light weight.

CHARACTERISTICS

Stall torque .33 oz.-in., no load speed 6400 R.P.M., time constant .0307 sec.

Kearfott components satisfy all requirements for high accuracy, light weight and small size.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Send for bulletin giving data of Counters and other components of interest to you.

Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

For more information circle **12** on inquiry card.

LETTERS—CONTINUED

The above is a highly conservative statement; almost defensively negative. What seems to have been squeezed out is the zest, the promise, the psychologically idealistic quality of a potentially brilliant change in our civilization.

Automation as a word contains more than its technological elements. It has unusual psychological and cultural ramifications. It has that force which may well change the human's view of himself in society. It is that kind of a word that historians pick up and point to as a turning point in the order of human events.

In the realm of engineering, in the experiment and development of equipment, I know it is best to employ radical doubt and examination on each new hard earned, uniquely found, progression, so that maximum results might occur. This is the tried and true method. But I also know that in the realm of idea and civilization, what is most important is the symbol and understanding of a *significant generality*. A banner has to be raised if a movement is to be done. The banner, you might say, is the favorable climate and protection that pervades around the internal growth of an historical development. The banner is also the carrier of enthusiasm and faith. Automation needs to be understood in more than a definition of its elements; it needs the assumption of a pervasive general idea—in short, a banner.

Jerome Zeitlin
Bayonne, N. J.

Your inspired letter calls for the raising of the "banner" of automation as the way to a new plateau of existence. You say that automation needs a "pervasive general idea—in short, a banner."

The word automation has been exactly the banner you say is needed. The word alone has done what you say needs to be done. It has generated a fever that has lead a thousand conferences to expend untold millions of words in rhapsodies about the new existence we are about to enter.

We believe in the flaming generality, but only after a careful groundwork of reality has been laid for the generality. Thus, we say that automation is *first* the substitution of mechanical, hydraulic, pneumatic, electrical and electrical devices for human organs of decision and effort—and *then* that automation is the way to a society in which productivity is so high that labor is needed for cre-

ative needs of the soul, not the physical needs of the body. The first definition is practical and true. The second is an inspirational definition that ignores completely the economic condition of society, a factor over which automation has no control, and a factor that will determine the economic health of the country more than will automation. So you see, flaming generalities are dangerous. Already, waving automation banners have alarmed organized labor and millions of working people, who see in the word the possible loss of their jobs.

Our nation, our people, our industry will benefit more from calm factual analyses of automation (and all other situations) than from crusades and waving banners.

Editor, I&A:

Dr. Baillif and I are very pleased with the preparation of this series of articles. It certainly proved a very enjoyable and easy task in preparing this series with you.

Millard H. LaJoy
Associate Professor
University of Minnesota
Minneapolis 14, Minn.

The series, a clear introduction to the important new field of dynamic analysis of plant plus controller, is now available in book form—"Process Control Analysis." It is a necessary first step in the approach to modern theories based on operational math or transfer functions. All process instrument men are urged strongly to start their "higher education" at this practical level.

Editor, I&A:

Several of us here have read your *Electronic Circuitry for Instruments and Equipment.* We wish to express our gratitude to you for having written an extremely informative, useful and thoroughly interesting text. The subject, to engineers in other fields, has previously vacillated between the realms of mysticism and total obscurity simply because of the unavailability of concise, readable literature with sufficient scope.

Robert J. Weaver
Assistant Soils Engineer
Department of Public Works
State of New York

Editor, I&A:

Enclosed is a M.O. for $4.00 for a subscription to *Instruments & Automation.* I am a Chem. Engr. working in Process Development and would like to have some basic knowledge on computers so as to find out what kind of computers exist, how they function (without going deep in calculus) and how they can be applied in our work. Some time ago we had a talk by a salesman from a manufacturer of computers, but he did disservice to computers because the engineers couldn't follow his use of technical terms which he didn't explain. So I will prefer to read something on computers, written in plain English.

Fred W. Miranda
Camas, Washington

As your subscription to *I&A* has just been entered, you probably have missed the wealth of basic educational material we have published on this subject in the last two years.

There are two basic types of computers—analog and digital. The digital in turn are divided into the two types—scientific and business. The fundamentals of all these types will be found in *The Computer Handbook,* which contains all the clinic class sessions of the First Computer Clinic of the First Automation Exposition. You will find, in particular, that the *general-purpose analog computer* and the *electronic data-processing-machine type computer* are clearly explained in this handbook. I suggest also that you register for the Computer Clinic of the Third Automation Exposition (see page 1185).

As to digital techniques, we have been featuring a series of articles on this subject since November, 1955. I strongly suggest that you obtain the issues since November and study each of these articles. We unabashedly claim this material to be the clearest and best educational material yet produced on the subject of digital techniques, which are also the fundamentals of digital computation.

Editor, I&A:

Being hospitalized as of late, I have had time to read (and admire) your magazine. One thing I'd like to ask—the ratio of complimentary letters to sourpuss letters seems phenomenally high. Are you being honest with us "D.R's"?

R. Francy
Steubenville, Ohio

Either most readers like I&A—or those who don't are too polite to tell us. This will probably start an avalanche of "sourpuss comments." We promise to print all that will get by the postal inspectors.

GRAY CODE
BINARY
BINARY
CODED DECIMAL

LIBRASCOPE
SHAFT POSITION-TO-DIGITAL

CONVERTERS

Equipped with ANTI-AMBIGUITY
DOUBLE BRUSH PICKOFFS

Useful in a wide variety of applications, including digital aircraft and missile controls, machine tool controls, digital readout from strip chart recorders, and as the modulator and de-modulator in pulse-code modulated radio links.

GRAY CODE MODEL – Capacity of 8 binary digits (single brush pickoff).
BINARY MODEL – Capacity of 7 to 19 binary digits.
BINARY CODED DECIMAL MODEL
Capacity range from 0-1999 to 0-35,999.

Units for special codes or capacities are built to meet specific requirements.

SHOCK ENDURANCE....................20g
TEMPERATURE RANGE..—50° to 83°C min.
CODE DISCS.......Rhodium plated phenolic
PICKOFFS............Multiple wire brush. Two pickoffs/channel
ROTATION......Continuous, either direction.

RUGGED—NON-MAGNETIC—LONG LIFE
MAY BE READ WHILE IN MOTION

SPECIAL CONVERTERS DESIGNED TO MEET
YOUR INDIVIDUAL PROBLEMS

Send for illustrated brochure

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808 Western Avenue • Glendale, California

For more information circle 13 on inquiry card.

GET THE BEST SOLUTION
TO EVERY FLOW

. . . with
Foxboro
Instrumentation

Differential Pressure Cell Transmitters

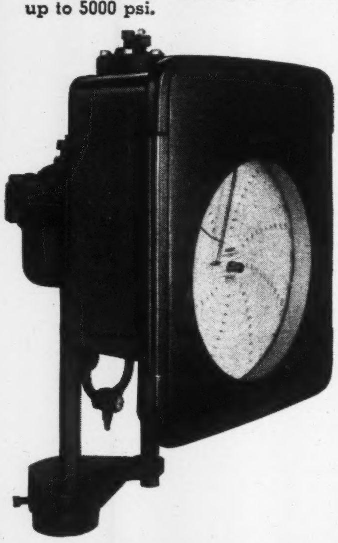
Complete line includes air-operated and electric-operated d/p Cell Transmitters covering ranges from 0-25" to 0-800" of water; working pressures up to 1500 psi.

Type 13A d/p Cell Transmitter

- Positive Overrange Protection—up to full 1500 lb. rating
- Fully Adjustable Ranges—0-20" to 0-80" and 0-50" to 0-250" water
- Automatic Internal Damping — fast, stable measurement
- Simplicity—easiest, lowest-cost installation, lowest maintenance

Mercury Type Meters

Complete line includes mercury types covering ranges from 5 to 400" of water; working pressures up to 5000 psi.



Type 28 Mercury Meter

- Permanent Full-Scale Meter Accuracy — exclusive segmental lever design provides linear transmission
- Highest-Powered Pen Drive — large float with long travel
- Minimum Ambient Temperature Effects — float located in high pressure chamber

F

- M
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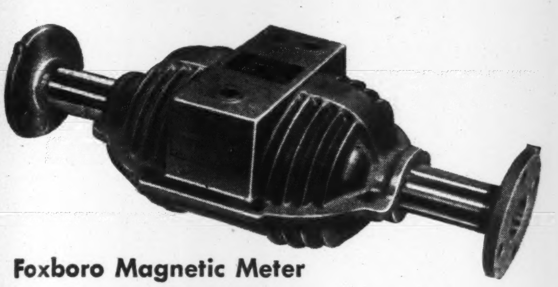
C

PROBLEM

THERE ARE two logical reasons why Foxboro Instrumentation assures you *optimum* results in measurement or control of process fluid streams. First; Foxboro offers the widest variety of measuring and controlling devices . . . the *right* equipment for every application. For example, only Foxboro offers all these basic meter types: differential pressure cell flow transmitters, magnetic meters, mercury meters, and weir meters. Second; Foxboro provides 45 years of engineering experience in every phase of fluid mechanics. From the simplest general utility-type instrument to complex automatic ratio control systems, you get highest accuracy, efficiency, and economy. Whenever you have a flow problem involving liquids, vapors, gases, or slurries — in pipes, ducts, or channels, you can solve it best by specifying Foxboro. Only a few instruments are described on these pages. For full details; or for specific information on *your* problem, contact your nearby Foxboro Field Engineer, or write The Foxboro Company, 466 Neponset Ave., Foxboro, Mass.



Foxboro Magnetic Meter

- **Measures Fluid Velocity Directly**
- **Adds No Pressure Drop**
- **Uniform Flow Scale**
- **Overall Accuracy Better than 1% of Range Over Entire Scale**
- **Full Accuracy Sustained Even on Liquids Other Meters Can't Handle — even sand and water slurries**

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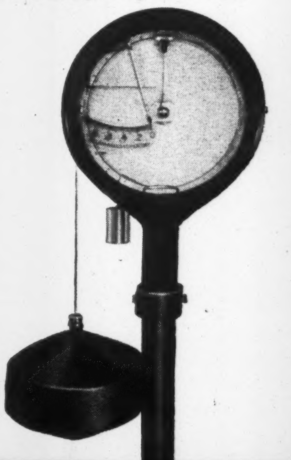
REG. U. S. PAT. OFF.

FIRST IN FLOW

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Float-and-Cable Type Meters

- **Rigid Construction — weather-tight case; all working parts of corrosion-resistant materials**
- **Powerful Accurate Operation — large, high-stability float; cable of spun glass and nylon—non-stretching, non-twisting**
- **Direct Reading Chart and Scale**
- **Direct Reading Integral Counter**



Other Foxboro Flow Instrumentation

Electric or Pneumatic Type Rotameters

Electric, Pneumatic, and Mechanical Integrators

Planimeters

All Primary Elements, Valves, and Accessories required for assembly of complete flow measurement and control systems

For more information circle **14** on inquiry card.

LEWIS

SELECTOR SWITCHES
FOR
RESISTANCE THERMOMETERS
AND
THERMOCOUPLE THERMOMETERS

EACH SWITCH HAS "OFF" POSITION PLUS NUMBER OF POINTS LISTED.

Points	Size	Switch Part Numbers Thermocouple Type	 3 Wire Resistance-Thermometer Type
2	2″	11S2	36SR2
3	2″	11S3	36SR3
4	2″	11S4	36SR4
5	3″	10S5	37SR5
6	3″	10S6	37SR6
8	3″	10S8	37SR8
9	3″	10S9	37SR9
10	3″	10S10	37SR10
12	3″	10S12	37SR12
16	3″	10S16	37SR16
18	3″	10S18	37SR18
20	3″	10S20	37SR20
24	4″	27S24B2	38SR24
28	4″	27S28B4	38SR28
40	4″	38S2C	

(No. 38S2C is made with soldering-lug terminals)

2" SIZE

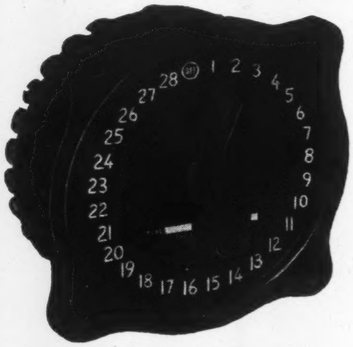
3" SIZE

SPECIAL SWITCHES

No. 37S6C2, Four "4 Point and OFF" thermocouple switches combined in one 3″ case.

No. 9S5, Single Pole, Four Point Instrument Switch in 1¼″ round case.

No. 44S4, Six Pole, Double-throw Instrument Switch in 2½″ round case, one hole mounting, ½-32 threaded bushing.


4" SIZE

DESIGNED FOR TEST WORK AS WELL AS FOR PERMANENT INSTALLATIONS. LEWIS SELECTOR SWITCHES ARE CONSTRUCTED WITH STURDY CONTACTS OF LOW RESISTANCE AND POSITIVE DETENT. THESE SWITCHES ARE SPLASHPROOF, DUSTPROOF AND ARE BUILT TO GIVE YEARS OF SERVICE.

THE LEWIS ENGINEERING CO.
Specialists in Electrical Temperature Measurements
NAUGATUCK, CONNECTICUT

For more information circle **15** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Gas distribution systems, and their instrumentation, are expanding rapidly. By end of 1953 there were 445,300 miles of utility gas mains in the USA, of which 393,900 were distributing natural gas, 29,700 mixed gas, 16,400 manufactured gas, 5,300 liquified petroleum gas. These mains served 26.7 million customers; of whom 19.9 million received natural gas, 3.6 million mixed gas, 2.8 million manufactured gas, and 0.3 million liquified petroleum gas. Although early gas systems were mainly manufactured-gas systems using pressures from 2"-5" w.c., utilization pressures now range from 4"-17" w.c., with most at 6"-8", says AGA. Tendency is use of higher pressures to obtain greater capacity.

Shortage of teachers in both high schools and colleges is mounting, reports NEA. Reacting to a survey of 673 private and public colleges (which employ 63,000 full-time teachers and enroll 1 million students), 246 reported teaching vacancies, including 92 in the physical sciences, 58 in engineering, 38 in mathematics. Situation is expected to worsen.

About 5000 engineers in reactor technology are now available in USA (including government); 50 to 65,000 wil be needed by 1975. About 14,000 engineers and scientists are now employed by AEC program—including biology, medicine, etc. Big drawback in training is huge investment needed by university: $700,000 plant investment plus $100,000 annual operating costs are required for $400,000 research reactor and curricula for 20 post-graduate specialists in reactor technology.

US Navy statistical analysis of reliability of electronic equipment has been made on more than 45,000 field reports on more than 6000 equipments--can lead to prediction at drawing board stage of reliability. (Details in Paper CP 55-588, AIEE).

Heating of body tissues by high-frequency radiation, first demonstrated by d'Arsonval in 1890, has become of general clinical interest since 1940, when the multi-cavity magnetron became available for production of microwave energy at powers of hundreds or thousands of watts. Becoming commercially available about 1947, there are now nearly 20,000 microwave diathermy machines being employed by physicians in the USA.

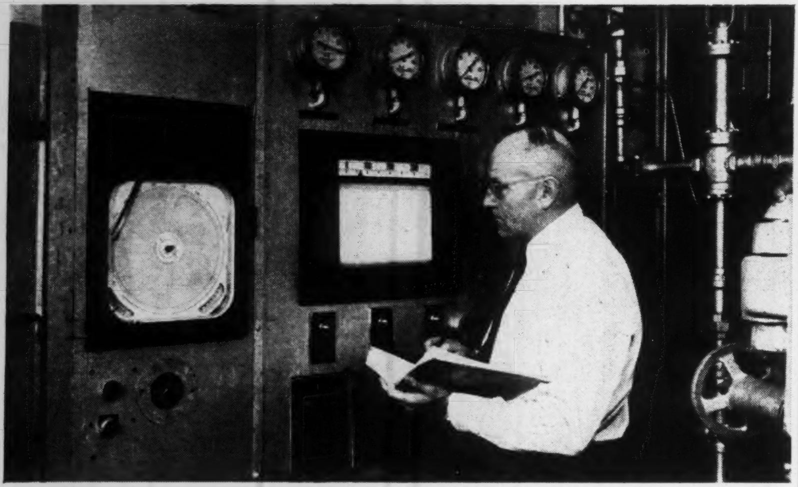
A problem raised by the above: There is no existing authoritative standard defining limits of time, intensity, or wavelength to prevent injury to the human body (the eye is most dangerous area), and no generally recognized safety practices, reports B. L. Vosburgh, General Electric Co., in "Symposium on Physiologic and Pathologic Effects of Microwave," IRE-PGME-4. Needed are exposure meters indicating absorption of microwave energy.

BRISTOL'S

Instrumentation News

• **News of instrumentation and automatic control in modern industry** •

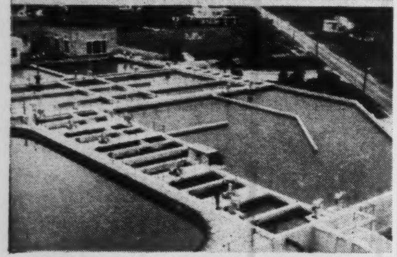
New vacuum process for stable powdered fruit juice



Powdered fruit juices that keep well for months, have no "off" odor or taste, and can be reconstituted simply by adding water are the result of a new vacuum process developed by the Western Utilization Research Branch of the U. S. Department of Agriculture.

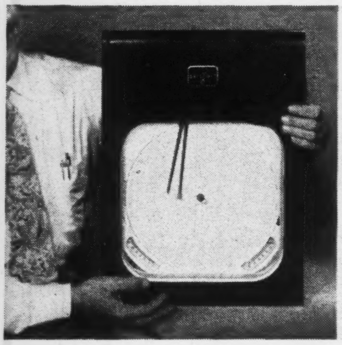
Orange, lemon, grapefruit, apple, tomato, grape or pineapple juices are processed by the new method, called "puff drying." A key feature of puff drying is continuous close pressure control in the range 1 to 4 mm Hg absolute by a Bristol Absolute Pressure Controller. These precision instruments are available with a total range as low as 0 to 6 mm Hg absolute if desired for such applications.

Constant pH for water plant



Despite wide variations in both flow and initial pH, this large municipal filtration plant puts out water at constant pH. The reason: a Bristol telemetering and control system. One of hundreds of similar problems solved by Bristol instruments.

Built-in calibration gives easy service



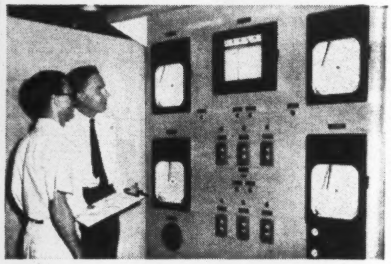
Simplest and easiest pneumatic control system on the market to service, the Bristol Series 500 Free-Vane Controller is exactly calibrated *with only one simple adjustment —even after complete disassembly and reassembly with replacement of parts.*

The reason? All working parts of the Series 500 Controller are so accurately designed and manufacturing tolerances are so closely held that calibration is effectively built into the controller.

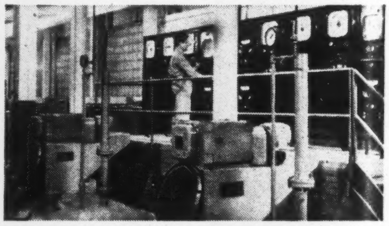
And, of course, all parts are interchangeable with those of any other Series 500 Controller. Almost anyone can service the Series 500!

Versatile Series 500 instruments are available in high-stability wide band widths to 400% and for on-off, 30% proportional, full proportional, reset, derivative, and reset plus derivative control. Write for complete information.

99% pure MSG produced with air control



Helping produce flavor-boosting monosodium glutamate (MSG) with at least 99% purity (in the fine chemical class) is the job of these Bristol air-operated controllers at Industrial Grain Products, Ltd., Montreal, a division of Ogilvie Flour Mills Co. Ltd. The Bristol instruments control absolute pressure and steam flow, and liquid levels in the new 1½ million dollar plant. Derivative action is used by some of the controllers for closer control.



Automation boosts foam rubber production

Automation is often thought of in terms of plans or even dreams; here at the Buffalo Foam Rubber Products Plant of the Dunlop Tire and Rubber Corporation, it is a reality. This automatic plant, designed and built by Mechanical Handling Systems, Inc., Detroit, uses Bristol Dynamaster® Electronic Instruments and Automatic Controllers as part of a process employing today's most advanced automatic production techniques. The result—greater efficiency and productivity, lower costs, improved product, and stronger competitive position. 6.26

Want more data on these Bristol instruments for your indicating, recording, or control needs? Write The Bristol Company, Bristol Road, Waterbury 20, Conn.

113

BRISTOL ***POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION***

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **16** on inquiry card.

INSTRUMENTS and AUTOMATION

Inquiries

These inquiries, representing problems facing readers of **Instruments & Automation**, are published as a free service to our readers.

Moisture in Fluffy Material

Engineer in carbon-black manufacturer's research lab is seeking controller for moisture contents in pellets formed from fluffy material. Range of moisture content to be controlled: 40 to 60%. A-100

Derivimeter

Electronic data processing engineer in large petroleum industry seeks "derivimeter" (possibly for rent) for obtaining second derivatives from drawings of contour profiles. A-101

Telemetering System

Development Engineer with large steam turbine manufacturer seeks system "to transmit information from inside a turbomachine." A-102

Holiday Tester

Manufacturer of testing equipment seeks "electronic apparatus for checking holidays (pinholes) in asphalt pipe wrappings." A-103

Miniaturized Light Source

Superintendent in plant manufacturing hygienic article is seeking supplier of miniaturized light source for use with photoelectric cells. Distance between light source and cell ranges from 1" to 6". A-104

Dewpoint Tester

Foreman of pyrometer department in metal-producing plant seeks source of supply for dewpoint tester for electro-dryer with range to −60° F. A-105

Small Hand Tools

Reader seeks source of supply for small hand tools used in electrical and aircraft instrument repair. A-106

Pulp Density Regulator

Export-Import company seeks manufacturer of "Resotronic" pulp and cellulose density regulator. A-107

Tracer Controls

Reader wants addresses of manufacturers of "Pneumatic Tracers", controlled elements for use with milling and profiling machines. A-108

Small-pitch Chain Drives

Chief engineer of testing machine company seeks manufacturers of chain drives preferably smaller than 3/16" pitch. A-109

BALZERS Thin Film Optics

From the Principality of Leichtenstein Swiss Customs Area

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Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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For more information circle **147** on inquiry card.

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ENGELHARD INDUSTRIES

For more information circle **17** on inquiry card.

Sold Down The River

Panhandle Pete

"Say Buss," says I, during a lull in the wives' conversation, "How's things over at Weirton? Anything new or exciting going on that I could write about?"

"Oh, Baker's flying around in low gear trying to get an open hearth control board going, and all of the meters aren't in yet," laughed Buss. "You know how Clarence is. On top of that he got another flowmeter in, and one day in the shop he and some fellow from Pittsburgh got into an argument about the check weights."

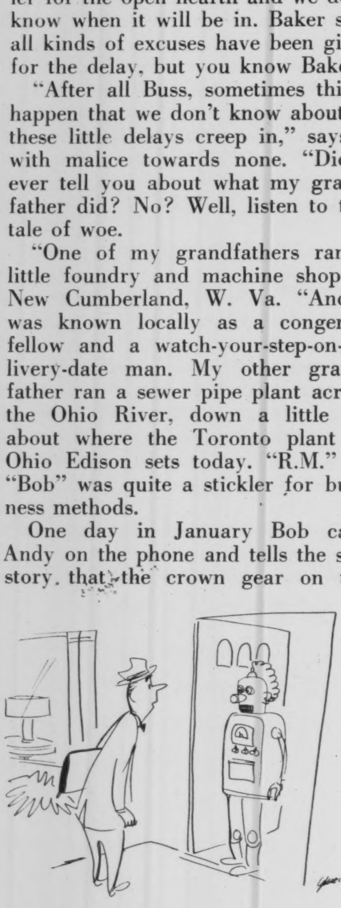
"Yeah, was the guy's name John Duesing, by any chance?"

"Well, I didn't meet the fellow so I'm not sure. Anyway we need a temperature difference recorder-controller for the open hearth and we don't know when it will be in. Baker says all kinds of excuses have been given for the delay, but you know Baker."

"After all Buss, sometimes things happen that we don't know about so these little delays creep in," says I, with malice towards none. "Did I ever tell you about what my grandfather did? No? Well, listen to this tale of woe.

"One of my grandfathers ran a little foundry and machine shop in New Cumberland, W. Va. "Andy" was known locally as a congenial fellow and a watch-your-step-on-delivery-date man. My other grandfather ran a sewer pipe plant across the Ohio River, down a little bit about where the Toronto plant of Ohio Edison sets today. "R.M." or "Bob" was quite a stickler for business methods.

One day in January Bob calls Andy on the phone and tells the sad story, that the crown gear on the clay mill is going to break and would Andy make him another and have it ready by the first week in June? Bob figures he could hold the thing together that long. The crown gear is a large heavy thing that one doesn't change every day and would require a shut-down of a week. "Why sure, Bob," says Andy, "I'll make a note of that and have it ready for you for sure." And promptly forgot it.



"HUH! ER ... IS THE PROFESSOR IN ?"

So time flies and Bob calls Andy every so often and Andy describes the progress of this gear through the shop. (Andy never started it.) About a week before the first of June, Andy is describing the finishing touches on the wheel to Bob when it suddenly dawns on Andy that the gear is due next week. So the shop is put on the rush gear job and naturally a thing like this can't be done in a week, with making a pattern, casting, machining, etc., but he has the thing pretty well along when the day comes when Bob sends up a gang to the ferry landing to get the gear. No gear! Nothing! So the phone rings and Andy answers it, thinking mighty fast, having a good idea who is ringing the bell so fast!

"Mr. —, Mr. — in Toronto wants to talk with you something about a gear," said the office girl with straight face.

"Bob," he says, "I hate to tell you but that crown gear of yours got away from the men as they were rolling it down the bank to put it on the ferry and the damned thing went into the river. I don't know when the river will be low enough to fish it out!"

"My Gawd, Andy, what'll I do? I got the whole plant shut down, all the stock worked out and here it is June, the start of good summer business," screamed grandpa Bob.

"Here's what I can do," says Andy very smoothly, "It just so happens that I have another gear going through the shop just like yours and if I can stall the other fellow off I'll let you have this one by next week."

"You will? I'll pay you an extra $100 for your trouble if I get that gear," sighed Bob, glad to get any kind of favor, so he thought.

"So you see Buss, that pyrometer Baker is waiting for is probably in Philly right now, only it is sold to somebody else, not him."

* * *

One reads odd things late at night when people are normally sleeping. Now, cast your eyes on the following excerpts from various instrument instruction books that nobody but me, apparently, has ever read:

"Tests have shown the grease contained in this tube to be the most satisfactory for the bearing in the recorder motor. We cannot accept responsibility for damage to motor or bearings if any other grease is used."

How do you like this? Is the above verbiage a guarantee or is it a quick pat on the back and a handshake in case we ever send back, for replacement, the barrel full of motors we know somebody has that have been fed a steady diet of grease?

"Where a synchronous (capacitor type) motor or induction motor is used, proceed as follows: The motor is equipped with end sealed type ball bearings and is thoroughly packed with grease before leaving the factory. It should, therefore, require no attention for at least a year or possibly even two years. It is further recommended that the ball bearings be replaced with new ones when they become objectionally noisy. To do this . . . etc."

I wonder who wrote this ponderous piece of philosophy. And isn't it a big wide, two-way street? Don't grease the motor bearings with the guaranteed grease so the bearings will wear out after the guarantee is up. I'll bet a "Philadelphia lawyer" wrote both of these little gems.

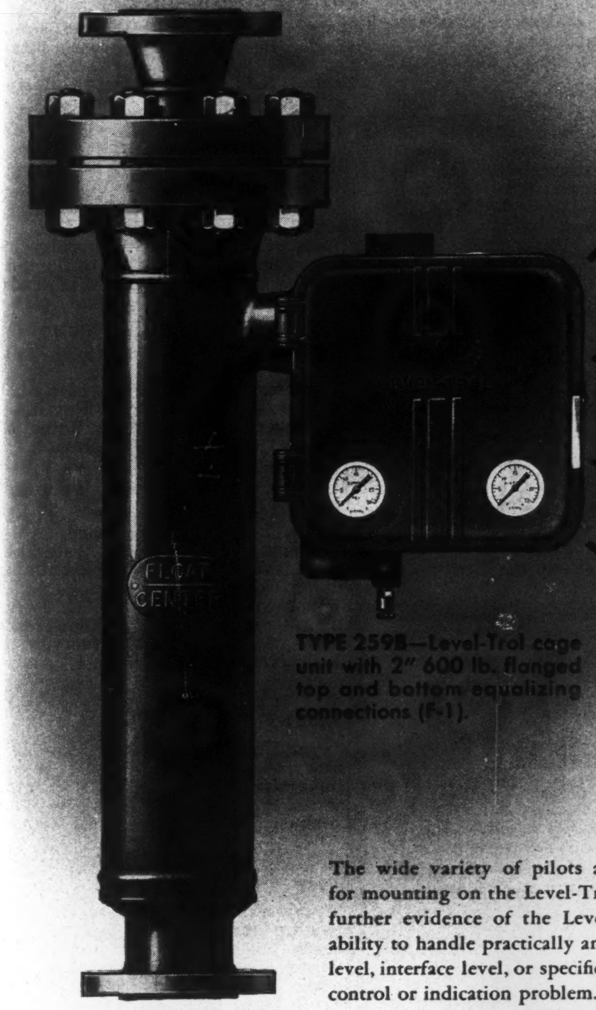
"Inspection—No inspection or regular maintenance of this instrument is necessary other than occasionally cleaning of the pen."

Let us all remove our hats, face towards the East and have a moment of silent prayer for the genius who, even though he is a glass-cage engineer, is only an advertising man at heart and does not understand what happens in steel mills. Although the above passage is as comforting to read as the Book of Psalms, it does little good when the "Bull of the Woods" is blowing cigar smoke down one's neck at 5:00 A. M. because "cleaning the pen" doesn't make the blankety-blank thing work.

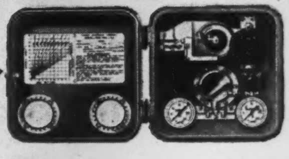
Panhandle Pete

FISHER® LEVEL-TROL

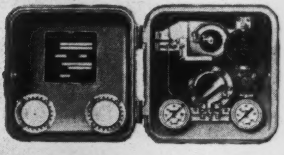
The Answer to Your Liquid Level Needs



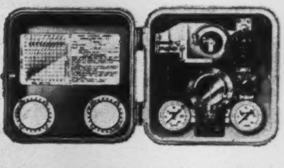
TYPE 259B—Level-Trol cage unit with 2" 600 lb. flanged top and bottom equalizing connections (F-1).



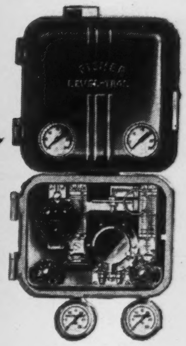
TYPE 2500—proportional pilot for general liquid level control applications.



TYPE 2500T — Level-Trol pilot used as pneumatic level transmitter.



TYPE 2500C—pilot with level indicator. Indicator available on all style Level-Trol pilots.



TYPE 2500 — 2516 dual Level-Trol pilot consisting of Type 2500 for remote level-indication or recording and Type 2516 controller with proportional and reset response.

The wide variety of pilots available for mounting on the Level-Trol gives further evidence of the Level-Trol's ability to handle practically any liquid level, interface level, or specific gravity control or indication problem.

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WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

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For more information circle **18** on inquiry card.

Analog Computing for One and All

with GAP/R modular components

The Model K2-X Operational Amplifier is an octal-based plug-in unit which nobly serves as nucleus for accurate feed-back computing.

With an output of ±100V the K2-X is priced at $24. The K2-W at $20. puts out an ample ±50V with less power needed.

Model K2-P is a Stabilizing Amplifier used in tandem with the K2-W or K2-X. It provides long term DC Stability measured in microvolts. All plug directly into the HK (shown below) or other environments. The K2-P having inherent stability below 0.1 MV is priced at $55.

The Model HK Operational Amplifier in the standard version offers 10 K2-W Amplifiers for analog calculations of infinite variety. A stabilized HK using K2-X and K2-P *"paired"* plug-ins provides greater output plus stability. The *standard* HK with 10 K2-Ws is $360. The *stabilized* HK with 5 of above "pairs" is $555.

Supplied also in a self-powered version as the compact Model HKR Operational Tenfold, all manifolds can be purchased in either *standard* or *stabilized* forms or in other combinations.

For rapid utilization of the HK or HKR, Model K- Modular Assembly units are offered either in kit form or assembled as Adder, Coefficient, Differentiator, Integrator or Unit-lag Passive Operational Plug-ins. Prices furnished on request.

One of the many "power packages" from GAP/R is the Model R-100 Regulated Power Supply, conservatively rated at 100 ma, ±300VDC, and modestly priced at $130.

Indicated below are two possible arrangements whereby your laboratory or engineering office can obtain a basic computing facility at minimum cost.

20 OPERATIONAL AMPLIFIERS Plus Regulated Power		10 STABILIZED AMPLIFIERS Plus Regulated Power	
2 HKs (with 20 K2-Ws)	$720.	2 HKs (10X's + 10 P's)	$1110.
1 R-100 Power Supply	130.	2 R-100 Power Supplies	260.
	$850.		$1370.

For more details and other information please write to:

George A. Philbrick Researches, Inc.
230 Congress Street, Boston 10, Massachusetts

GAP/R

For more information circle **19** on inquiry card.

INSTRUMENTS and AUTOMATION Events

For other computer Events see page 1150.

June 25-27

Stanford Research Institute and University of California Symposium on "High Temperature—A Tool for the Future", University of California, Berkeley, Calif.

June 25-29

American Institute of Electrical Engineers, Summer & Pacific General Meetings, San Francisco, Calif.

June 25-July 7

Aerodynamics Heating of Aircraft Structures in High-Speed Flight. Massachusetts Institute of Technology. For information write to Summer Sessions Office, Rm. 7-103, MIT, Cambridge 39, Mass.

June 27-July 6

Annual Meeting of International Electrotechnical Commission, Munich, Germany. For information write to U. S. National Committee, c/o American Standards Assoc., 70 E. 45th St., New York 17, N. Y.

July 8-11

National Office Machine Dealers Assn., Shamrock Hotel, Houston, Texas.

July 9-20

Short Course in linear automatic control system synthesis, Purdue University, Lafayette, Ind.

July 10-12

Sixth Exposition of Western Packaging and Materials Handling, Pan Pacific Auditorium, Los Angeles, Calif.

July 10-12

EAC Trade Show Clinic & "Show for Shows", Morrison Hotel, Chicago, Ill.

July 16-20

Unit Processes in Fatty Oil, Soap, and Detergent Industries, sponsored by American Oil Chemists Society, Purdue University, Lafayette, Ind.

July 16-20

Strain Gauge Techniques sponsored by Massachusetts Institute of Technology, Cambridge 39, Mass. For information write Summer Sessions Office, Rm. 7-103, MIT, Cambridge 39, Mass.

July 16-21

International Organization for Standardization, Geneva, Switzerland.

July 16-27

Course in Modern Industrial Spectrography, Boston College, Boston, Mass. For more information write James J. Devlin, S.J., Physics Dept., Boston College, Chestnut Hill 67, Mass.

July 16-27

Hydrodynamic Stability and Theory and Practice of Ceramic Forming, sponsored by the Massachusetts Institute of Technology, Cambridge 39, Mass. For information write Summer Sessions Office, Rm. 7-103, MIT, Cambridge 39, Mass.

July 22-28

8th International Congress of Radiology, Mexico City, Mexico, For information write Jose Noriega, Tepic 126 (2e piso), Mexico, D.F. 7, Mexico.

July 23-27

Gordon Research Conference on Instrumentation, American Association for Advancement of Science, Calley Junior College, New London, N. H. For information write W. G. Parks, Dir., Gordon Research Conference, Dept. of Chemistry, University of Rhode Island, Kingston, R. I.

July 23-August 11

Wayne University Computation Laboratory, Summer Program, Wayne University, Detroit, Mich. For information write A. W. Jacobson, Dir., Computation Lab., Detroit 1, Mich.

August 9-10

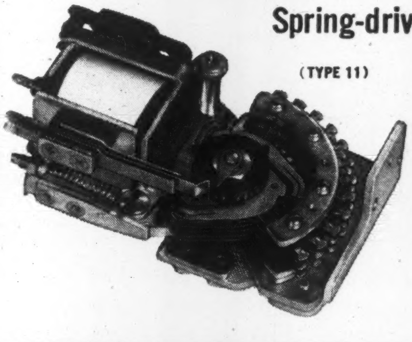
Fifth Annual X-ray Analysis Symposium, sponsored by Denver Research Institute of Univ. of Denver, Denver, Colo. For information write James P. Blackledge, Denver Research Inst., Univ. of Denver, Denver 10, Colo.

August 15-17

National Turbine Powered Air Transportation Meeting, sponsored by Institute of Aeronautical Sciences. For information write Inst. of Aeronautical Sciences, 2 E. 64th St., New York 21, N. Y.

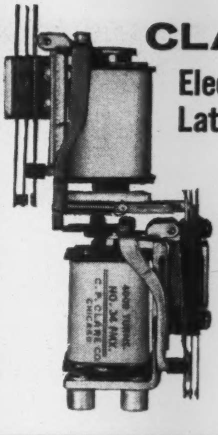
Circle **20** on inquiry card. →

CLARE
Spring-driven Stepping Switch



(TYPE 11)

Latest in CLARE line of uniselectors, or rotary switches for completing, interrupting or changing connections in a succession of electric circuits in response to momentary impulses of current. Provides millions of steps without readjustment. ***Send for CLARE Bulletin No. 121.***



CLARE
Electromechanical Latching Relays

Assembly consists of two CLARE a-c or d-c relays with interlocking armatures. One a-c and one d-c relay may also be used. Many of these relays still operating satisfactorily after well over 15,000,000 operations. ***Send for CLARE Bulletin No. 118.***

New CLARE RELAY designs keep pace with demands of modern high-speed equipment

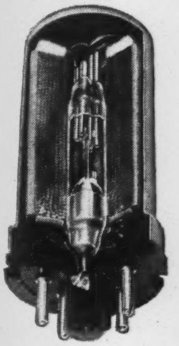
CLARE RELAYS for use in modern high-speed devices differ in size, shape, appearance and characteristics to meet a wide range of design requirements.

One factor they have in common—ability to deliver accurate and dependable performance for millions, yes even billions, of operations WITH NO MAINTENANCE WHATSOEVER.

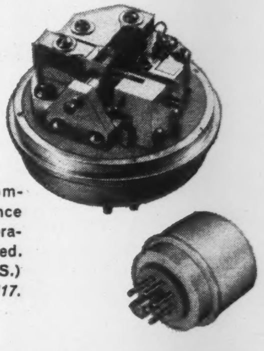
A few of these outstanding CLARE developments are shown. There are many more. If your relay problem is new or unusual, CLARE sales engineers, located in key cities, may be able to bring you quickly just the relay you need. Contact C. P. CLARE & CO., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. CLARE & CO., 659 Bayview Avenue, Toronto 17. Telephone: Mohawk 3829.
Cable address: CLARELAY.

CLARE
Mercury-Wetted Contact Relays

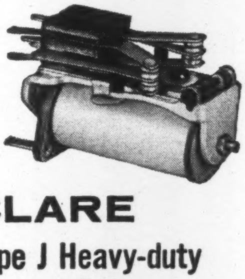
A relay of the utmost accuracy and dependability which is capable of over a billion operations at speeds to 60 operations per second. Cutaway view shows mercury-wetted contact switch sealed in glass. Available with up to 4 switches for multiple circuits. ***Send for CLARE Bulletins Nos. 120 and 122.***



CLARE
High Frequency Impulse Relay



A highly sensitive relay completely free from contact bounce and capable of billions of operations at extremely high speed. (Will follow up to 2,500 CPS.) ***Send for CLARE Bulletin No. 117.***

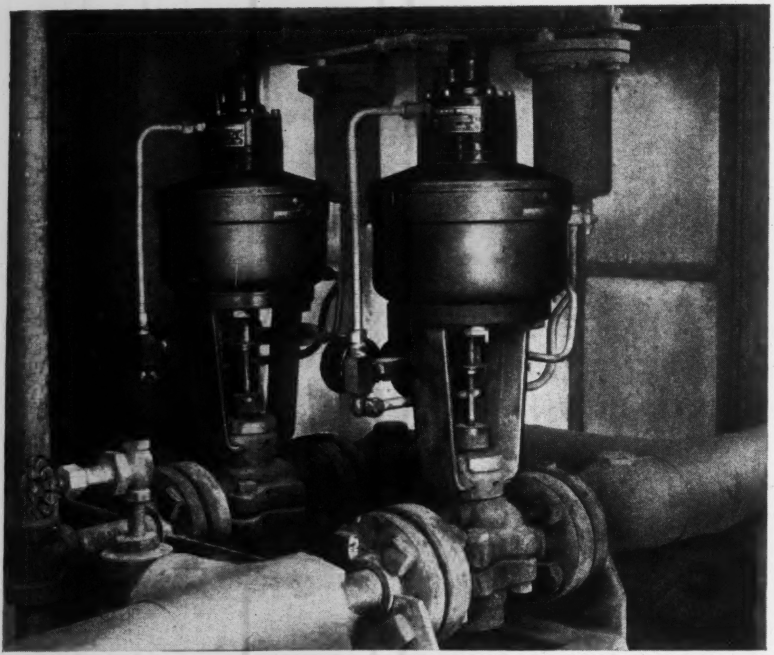


CLARE
Type J Heavy-duty Contact Relay

Increased current carrying capacity is provided by the use of silver heavy-duty contacts which are riveted to the springs. Rating of 10 amperes, 27½ volts d-c. Has exceeded 500,000 operations on motor load of six amperes—inrush current of 15 amperes—at 70,000 feet altitude. ***Send for CLARE Bulletin No. 119.***

CLARE RELAYS

FIRST in the industrial field



600 to ONE CUSTOMER PROVES SATISFACTION...

THAT'S THE STORY BEHIND THESE CONOFLOW Series LB CONTROL VALVES

Photo shows an original installation of Conoflow Series LB Control Valves that has been on a temperature control application for several years. There are now over 300 of these valves in operation at this large manufacturing plant. By the end of the year there will be approximately 600 LB valves throughout the plant. Out of respect for our customer's company policy we cannot publish the name. However, the volume of valves involved proves that Conoflow Series LB Control Valves are eminently satisfactory to this prominent user.

The tandem operation shown is a typical application—cooling and heating—utilizing split ranges. One valve handles cold water with a 3-9 psi range. The other handles steam with a 9-15 psi range.

The revolutionary Cylinder Conomotor provides greater speed of response, tight shut-off and other performance characteristics superior to conventional valves. Downtime is practically nil compared with other valves.

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FOREMOST
IN FINAL CONTROL ELEMENTS

Catalog LB-1 tells the complete story of the benefits in Conoflow Series LB Control Valves. Write for your copy. Conoflow representatives are located in most principal cities.

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For more information circle **21** on inquiry card.

EVENTS—CONT.

August 19-24

6th International Symposium on Combustion, Yale University, New Haven, Conn. For information write Combustion Symposium, Mason Lab., Yale U., 400 Temple St., New Haven 11, Conn.

August 20-21

National Telemetering Conference, sponsored jointly by IRE, AIEE, IAS and ISA, Ambassador Hotel, Los Angeles, Calif. For information write D. M. Cullar, Farnsworth Electronics Co., 3702 E. Pontiac St., Ft. Wayne, Ind.

August 21-24

1956 Western Electronic Show and Convention, Pan-Pacific Auditorium, Los Angeles, Calif.

August 22-Sept. 1

23rd Annual (British) National Radio Show sponsored by Radio and Electronic Component Manufacturers Federation, Earls Court, London, England.

August 27-29

11th annual meeting of Association for Computing Machinery at Westwood Campus, University of Calif., Los Angeles, Calif. For information write Assoc. for Computing Machinery, Box 3251, Olympic Sta., Beverly Hills, Calif.

August 27-31

7th Annual Infrared Spectroscopy Institute, Fisk University, Nashville, Tenn.

September

8th International Congress for the History of Science, Milan or Florence, Italy. For information write Pierre Sergescu, Secretary of Union, 7 Rue Daubenton, Parie 5e, or G. Ucelli, IUHS, Via Cappuccio 7, Milan, Italy.

September 5-13

9th International Congress of Applied Mechanics, University of Brussels, Brussels, Belgium. For information write Secretary, The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

Sept. 17-21

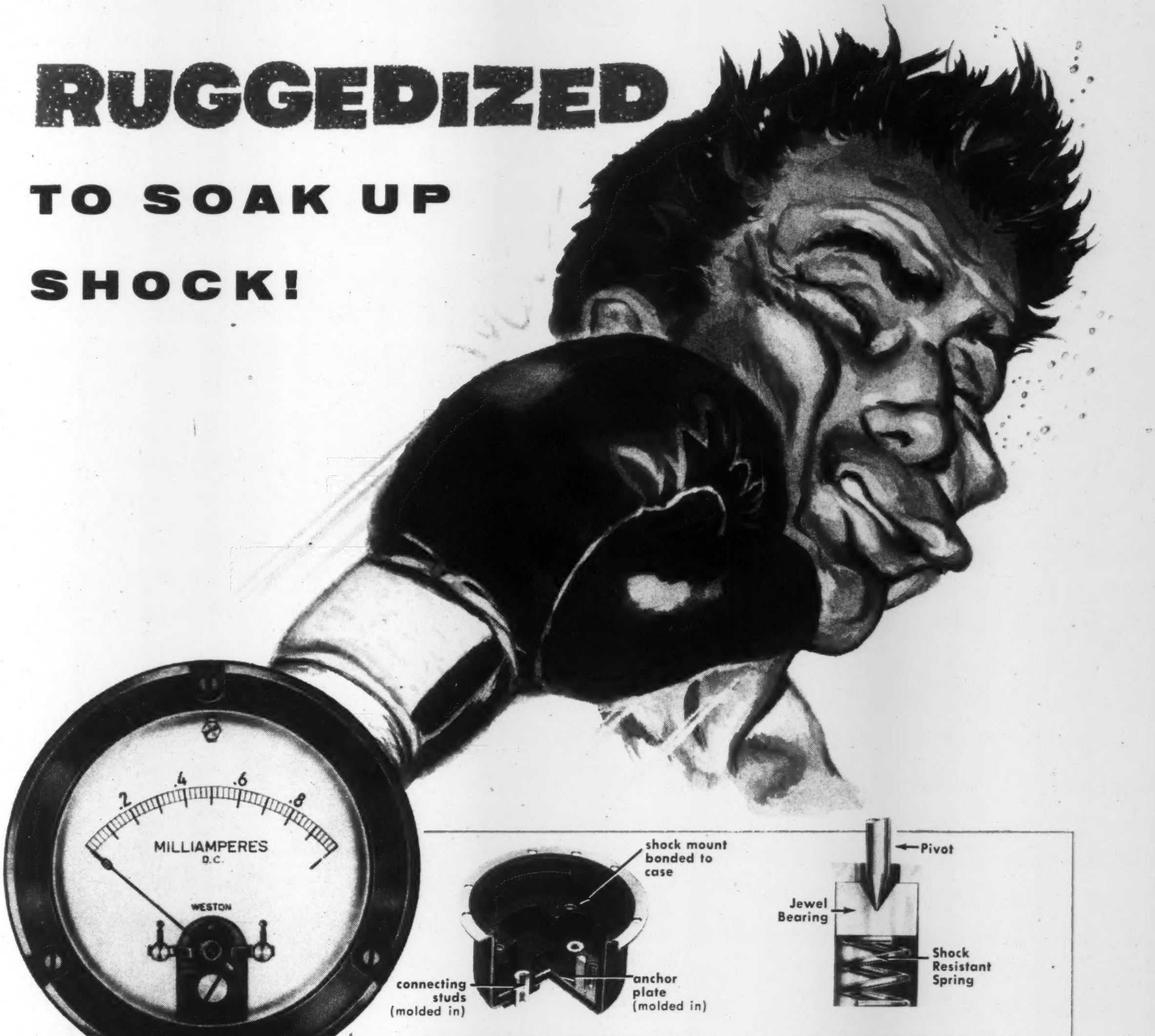
11th Annual Instrument Society of America Conference and Exhibit, New York Coliseum, New York, N. Y. For information write William H. Kushnick, ISA, Granite Bldg., 313 Sixth Ave., Pittsburgh 22, Pa.

November 26-30

Third International Automation Exposition, New York Trade Show Building, 500 8th Ave., New York, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Penna.

RUGGEDIZED

TO SOAK UP SHOCK!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shock mount bonded to case
connecting studs (molded in)
anchor plate (molded in)
Pivot
Jewel Bearing
Shock Resistant Spring

Cutaway view of instrument case showing how the ruggedized WESTON movement is cradled on a shock mount of specially formulated rubber. Case is completely lined for high dielectric strength.

Tiny springs in back of each jewel bearing in WESTON ruggedized instruments *soak up shock* — thus eliminate damage and help insure dependable operation in severest service.

Where specifications read "ruggedized", it means instruments that can really *take* punishment, *and come through!* That's why WESTON is industry's *major* supply source, and the *exclusive* source for ruggedized panel instruments in *all* sizes in A-C, D-C, RF, and THERMO types. For the complete story on WESTON ruggedized meters, as well as on the full line of conventional and core-magnet type panel meters, consult the Weston representative near you, or write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J. A subsidiary of Daystrom, Incorporated.

WESTON

RUGGEDIZED

PANEL INSTRUMENTS

For more information circle **22** on inquiry card.

New thermocouple extension wire flame-proof, weather-proof

. . . available through your

HSM

HONEYWELL SUPPLIES MAN

HERE'S a thermocouple extension wire with superior insulation. Each of the two solid conductors is insulated with .015″ polyvinyl, and the pair is further protected by an outer .02″ polyvinyl jacket. It's the ideal wire for even the toughest service. What makes it better than ever is a *new kind* of polyvinyl insulation that gives these qualities:

Won't become tacky or stick to conduit walls, even when overheated.

Won't support flame. Fire merely chars the coating. You can rewire without replacing the conduit.

Abrasion-resistant. Jacket won't break or fray in roughest service.

Easy to pull through conduit because jacket is smooth.

Weather-proof . . . double vinyl insulation gives extra protection.

Moisture-resistant. *Completely* moisture-resistant.

Flexible. Can be flexed safely . . . will not crack or split.

Ask your local HSM (Honeywell Supplies Man) to tell you about this new wire . . . and to discuss how the HSM Plan can bring new convenience and economy to all your pyrometer supplies purchases. Call him today, at your local Honeywell office . . . as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:**
Write for Specification S002-1, and for Pyrometer Supplies Buyers' Guide No. 100-6.

H
HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

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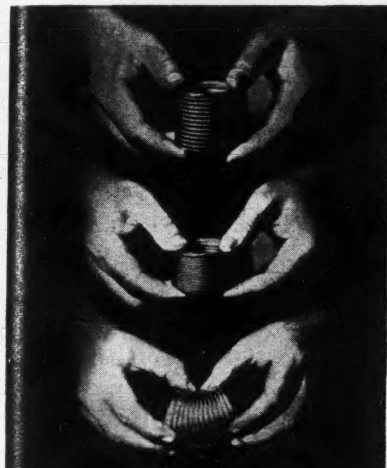
5 REASONS FOR BUYING BELLOWS FROM FULTON SYLPHON



Seamless Metal Bellows

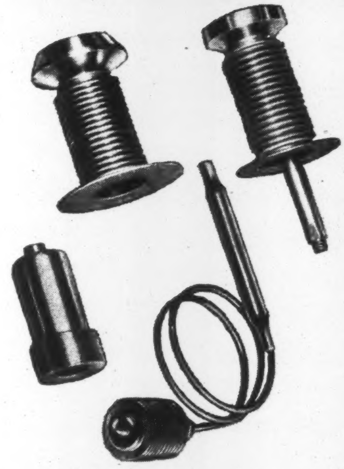
One-piece design—no soldered joints—assures longer life.

All Types, Sizes and Metals

Designed to your individual requirements and specifications.

On-Call Engineering Service

Fulton Sylphon Bellows Engineers provide quick, reliable advice on application problems.



Assemblies and Complete Devices

Bellows and related parts fully assembled with big savings in time, trouble, and money.

On-Time Delivery • No Delays

Modern facilities, strict quality control, and follow-through eliminate customer worries.

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BELLOWS HEADQUARTERS,

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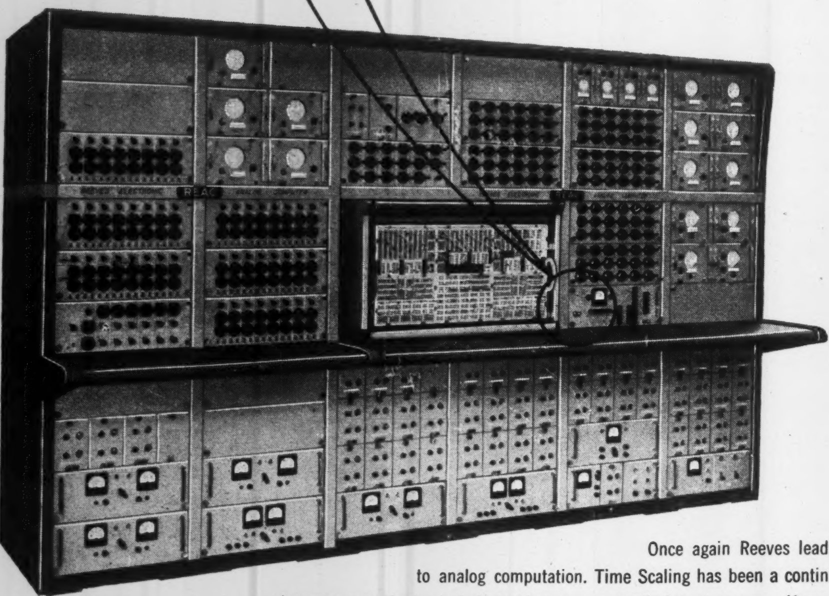
For more information circle **24** on inquiry card.

Another Computer FIRST

...by **Reeves** INSTRUMENT CORPORATION



BUILT-IN
TIME SCALE CHECK

Once again Reeves leads the field with a major contribution to analog computation. Time Scaling has been a continued source of difficulty in analog computation because even the best of electronic components will introduce errors if operated beyond their frequency range.

Now for the first time, Reeves offers as a built-in feature of the REAC® "400" computer a simple, positive "Time Scale Check" which determines, without disturbing the problem set-up in any way, if any computer component is operating beyond its frequency range. The new check is extremely simple and easy to perform, and requires little additional equipment in the computer.

"Time Scale Check" is another example of Reeves' pioneer engineering in the analog computer field. Reeves developed the first Electronic Analog Computer, and the list below gives some of the other important Reeves "firsts" since that time. Reeves is continually striving to improve its product and give you the very best in analog computers. Why not put this experience to work for you?

FIRST DC computing amplifier with capacitor to grid to eliminate the effect of grid current on integrator drift.

FIRST commercial chopper stabilized DC computing amplifier (based on an RCA invention).

FIRST commercial AGC for use with resolvers in polar mode.

FIRST commercial plotting board for analog computers.

FIRST diode electronic multiplier circuit requiring only three amplifiers with zero output for zero input.

FIRST commercial pre-patch system for analog computers.

FIRST commercial curve follower function generator.

FIRST absolute overload indicator system for computing amplifiers.

FIRST commercial use of cascode output computing amplifiers (for high power output with low quiescent drain).

FIRST commercial printed circuit DC computing amplifier.

FIRST commercial use of loaded tapped potentiometers for servo function generation.

FIRST commercial time division electronic multiplier.

FIRST diode function generator for function of two or more variables.

FIRST use of taper pin construction in analog computers for easy wiring and testing.

FIRST commercial wide-band, 400-cycle servo multiplier.

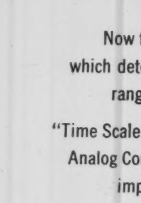
FIRST 6-channel recorder with automatic recording of calibration data.

FIRST commercial problem check system.

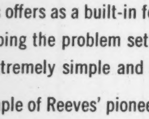
REMEMBER—ONLY REEVES MAKES **REAC** COMPUTERS!

Reeves INSTRUMENT CORPORATION

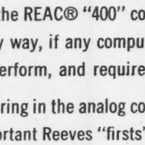
REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America
225 East 91st Street, New York 28, New York



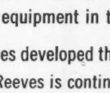
REAC Analog Computers



Precision Floated GYROS



Precision RESOLVERS and PHASE SHIFTERS



SERVO MECHANICAL PARTS

7RV56

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In color tv, too

CRUCIBLE PERMANENT MAGNETS

for beam correctors, color purifiers and color equalizers give maximum energy . . . minimum size

Designers of electronic and control equipment can count on a *consistently higher* energy product with Crucible alnico magnets. *It means greater power from a minimum size magnet!*

And they're available in practically any size you want—from a fraction of an ounce to several hundred pounds. What's more, Crucible alnico permanent magnets can be sand cast, shell molded, or investment cast to your exact size, shape, or tolerance requirements.

Crucible has been a leading producer of these permanent magnets ever since alnico alloys were developed. And their manufacture is backed by over a half century of fine steelmaking experience. That's why so many magnet applications begin at Crucible.

Crucible Steel Company of America,
The Oliver Building, Mellon Square,
Pittsburgh 22, Pa.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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INSTRUMENTS and AUTOMATION News

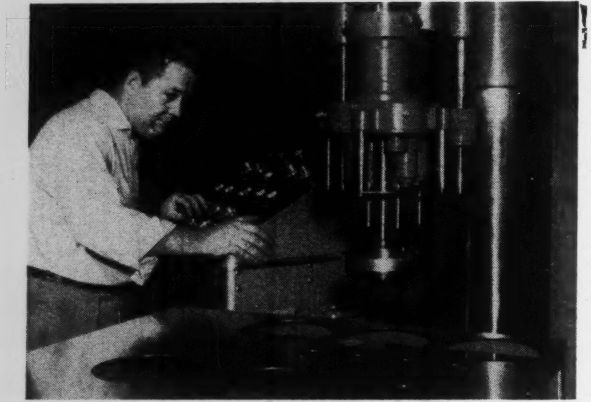
Principles & Applications 1070 to 1082
Stock Report 1082
New Plants & Mergers ....1087 to 1088
People in the News ....1093 to 1094

AIEE Forms Instrumentation Division

NEW YORK, N. Y.—The Committee on Instruments and Measurements, at present part of the Science and Electronics Div., AIEE, will begin operation as a sixth Technical Division August 1, headed by C. F. Savage, Jr. of GE.

-Tool Automation

PHILADELPHIA, PA.—Turning a few dials and pushing some buttons is all that it takes to operate Minneapolis-Honeywell's recently developed electronically controlled automatic drilling machine. An operator simply dials the coordinates of hole location on the console.



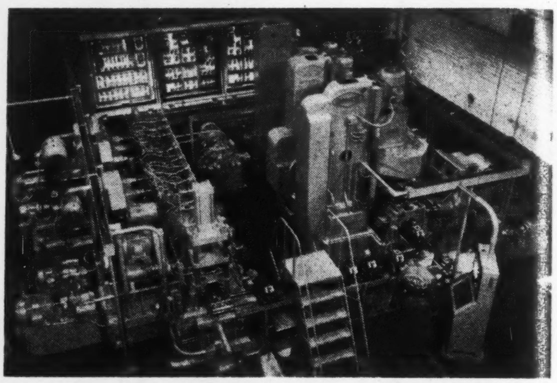
GE to Build ERMA's for Bank

SAN FRANCISCO, CALIF.—The Bank of America has given GE's Electronics Div., Syracuse, N. Y., a contract for the manufacture of several ERMA units (electronic recording machine—accounting) described as the largest civilian order for industrial computers. Space will be leased from Standard Research Institute, developers of ERMA, at its Menlo Park (California) headquarters. Each ERMA can perform the daily bookkeeping tasks for 55,000 commercial checking accounts.

Automation in Valve Machining

STRATFORD, CONN.—Manning, Maxwell & Moore, will put an automatic transfer machine to work at the Watertown, Mass. plant for the manufacture of its Hancock gate-type high-pressure steel valves. While the old method produced about 19 finished valve bodies per hour, production with the new machine will be stepped up to 73 per hour.

Operated by one man from a master control board, 26 operations will be carried out simultaneously in as many stations.

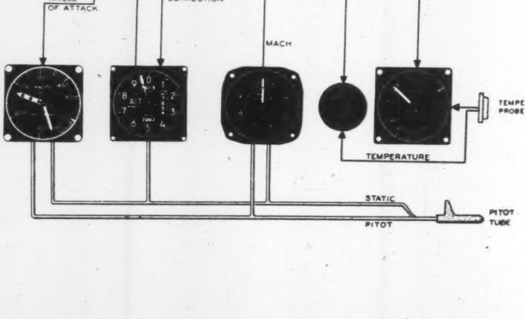


Specular Glossmeter

WASHINGTON, D. C.—A standardized method for gloss measurements (primarily intended for porcelain enamel) recently was developed by the National Bureau of Standards. Following a recommendation of the Porcelain Enamel Institute the gloss scale closely approximates that of the widely used Hunter multipurpose reflectometer, developed by NBS in 1936. The instrument used for the measurements was a goniophotometer which was so adjusted as to furnish a scale similar to the Hunter instrument.

Flight Instrument System

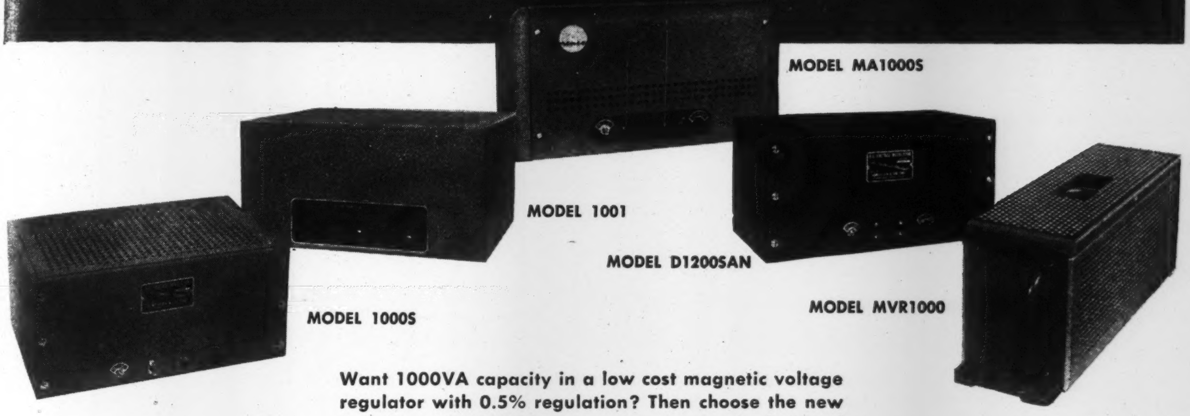
ELMHURST, N. Y.—Conventional pressure instruments plus a computer form a new Integrated Flight Instrument System. System includes a new high accuracy altimeter, a Machmeter, an airspeed indicator (which



SORENSEN

ENGINEERS *STANDARD* MODELS TO MEET *SPECIAL* REQUIREMENTS

to illustrate this flexibility, engineers can now choose from five 1000VA regulators!



MODEL 1000S — Automatic wide-range electronic regulation with the original Sorensen frequency insensitive circuit incorporating the safety diode. Regulation ±0.1%.

MODEL MA1000S — For unattended installations requiring extremely dependable automatic line regulation. This tubeless unit offers stable long-life performance with minimum maintenance. Regulation ±0.5% over wide frequency range.

Want 1000VA capacity in a low cost magnetic voltage regulator with 0.5% regulation? Then choose the new Sorensen MVR1000; compact, economical. Need 1000VA, but with *0.01%* regulation? Then choose Model 1001. For *any* requirement, *any* application, there's a Sorensen 1000VA unit engineered with you in mind.

And the same thing is true for practically *any* specified requirement in the field of regulated power — whatever you need, Sorensen makes it now or will make it to do exactly the job you want done, within the limits of your particular application. Sorensen offers you the widest possible range of characteristics. For research or industry, call on Sorensen — ***the world's authority on regulated power.***

SEND FOR 1956 CONDENSED CATALOG

New and more complete — gives condensed specifications on a wide range of units for a variety of applications. Be sure you have all available information when you specify — send for your copy today!

MODEL 1001 — Developed from unique, dependable Sorensen regulating circuit, refined for ultra-precise ±0.01% regulation.

MODEL D1200SAN — ±0.25% regulation for 400 cycle industrial and aircraft requirements up to 1200VA.

MODEL MVR1000 — New low cost compact magnetic voltage regulator for less exacting applications. Fully automatic ±0.5% regulation with fast response time.

Sorensen

SORENSEN & COMPANY, 375 FAIRFIELD AVENUE, STAMFORD, CONN.

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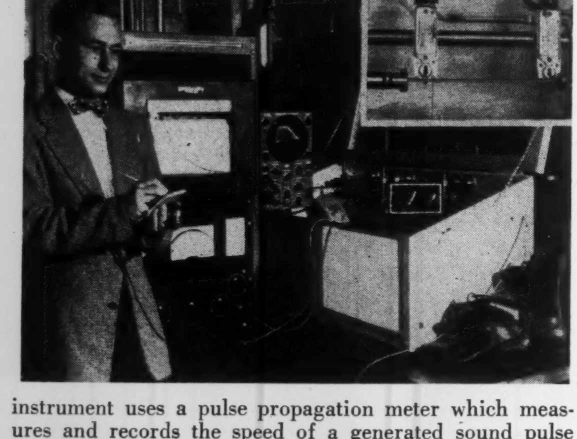
gives minimum indicated and maximum allowable airspeed and minimum safe speed for approach and landing, and most efficient cruising speed), a true-airspeed indicator and a thermometer indicating true outside air temperature. System is built by Kollsman Instrument Corp.

Infrared Analyzer Tests Heaters

MERCER, PA.—To meet rigid AGA test requirements, Reznor Mfg. Co., Mercer, is testing all gas-fired furnaces leaving the production line with a Mine Safety Appliances Co. LIRA-type infrared gas and liquid analyzer; CO and CO_2 quantities produced by the flame are recorded and checked, and necessary adjustments are made. LIRA's sensitivity is in the range of 2 to 200 ppm and down to 0.5 ppm in specific cases.

Leather Testing

WASHINGTON, D. C.—A nondestructive method for testing leather, based on transmission of sound waves, has been developed by the National Bureau of Standards. The instrument uses a pulse propagation meter which measures and records the speed of a generated sound pulse through the leather. Sound transmission in leather varies substantially with changes in chemical and physical structure and, particularly, in fiber orientation.



Education News

PITTSBURGH, PA.—With the widely publicized shortage of engineers and scientists it is interesting to follow the news in the education field that reached our desk this month:

- 1500 members of the American Society for Engineering Education (ASEE) will gather at Iowa State College June 25 through 29 to listen to 200 papers on engineering education. Senator Bourke B. Hickenlooper of Iowa will be the principal speaker.

- The New York State Department of Labor reports in it's *Industrial Bulletin* of a program registered by Edward Labs Co. of Wappinger Falls to create a new apprenticeable trade called *electronic laboratory technician*, aimed at relieving electronic engineers of minor duties for performance of more important tasks . . . also of another program for *machine tool mechanics* in the field of *automation*, registered by Seneca Falls Machine Co.

- The National Merit Scholarship Corp., a non-profit Illinois organization, announced more than 500 winners of yearly scholarships, worth about $6000 each, for future leaders in the field of engineering and sciences, selected in free competition from the approximately 25,000 secondary schools in the nation. Founded only 8 months ago with $20½ million from the Ford Foundation and the Carnegie Corp. of New York, 19 leading corporations have joined in with contributions that swelled the originally earmarked one million dollars to over $3 million per year.

- Port Chester, N. Y., Senior High School has installed General Precision Lab's portable unattended TV cameras as aids in bringing closeups of demonstrations in science classes to the students in the room and other classrooms.

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- President Eisenhower, on April 3, established a National Committee for the Development of Scientists and Engineers. Its importance is emphasized by the roster of the 19 members who come from the Universities, the fields of Engineering, Science, Education, Management, Labor, State and Local Governments and Humanities, and reads like a "Who's Who."

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- The EMC-SMC Newsletter issued by the Engineering Manpower Commission of Engineers Joint Council and

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✓ *Better Circuit Identification*
✓ *More Beautiful Panels*

5 ways better

Hex thumb nut with insert captive with stud.

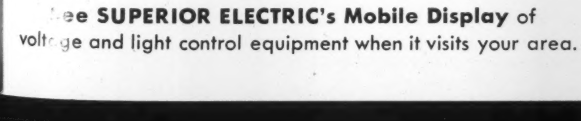
Panel insulator of durable phenolic, molded over brass core frozen to center shaft. Flatted insert for locking to panel.

Twin Hexagonal 10 x 32 brass nuts.

Hole in center shaft for wire up to size No. 12.

Sliding panel-mounted insulator. Flatted insert for locking to panel.

ways to bind



1. Plug-in for standard ¼″ banana plug
2. Clip-lead to shaft
3. Wire looped around shaft and clamped
4. Wire (up to No. 12) permanently clamped through hole
5. Clamped spade lug connection

See **SUPERIOR ELECTRIC's Mobile Display** of voltage and light control equipment when it visits your area.

The SUPERIOR 5-WAY Binding Post has been the first choice of electrical and electronic equipment designers because it provides *flexibility*, *rugged construction*, and assurance of complete insulation. Now you have your choice of SUPERIOR 5-WAY Binding Posts in 5 colors that will help you design more beautiful panels and will aid in easy circuit identification. Write for Bulletin BP456.

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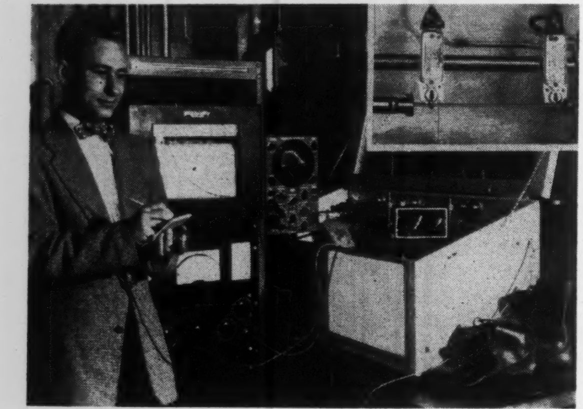

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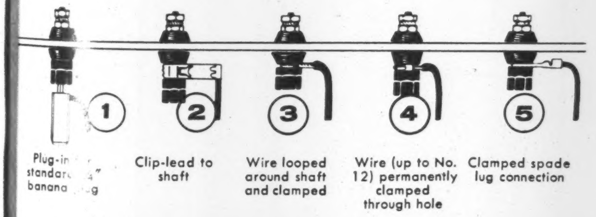

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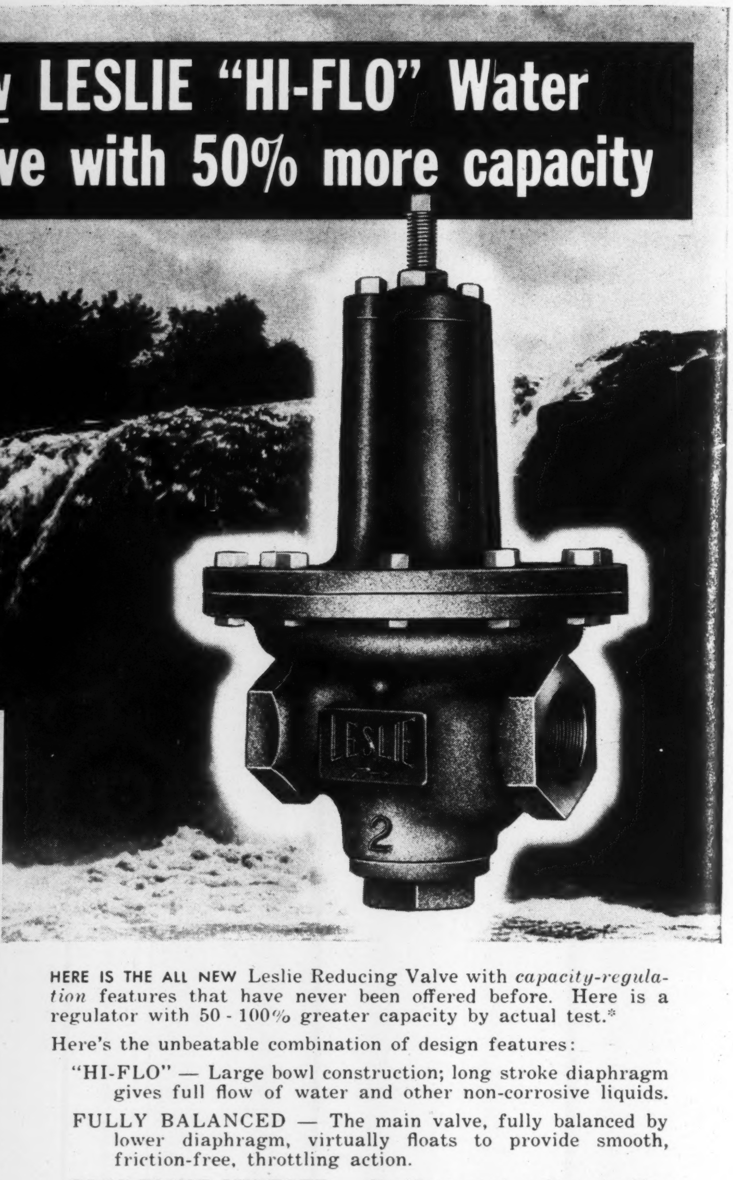
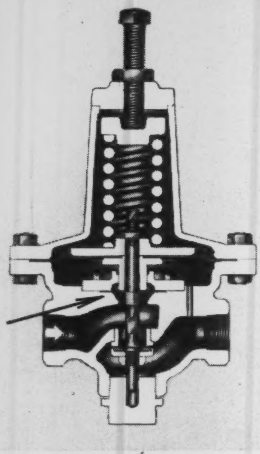
Here is the new LESLIE "HI-FLO" Water Reducing Valve with 50% more capacity



It's Fully Balanced



Unique construction of "Hi-Flo" Reducing Valve. Note the small lower diaphragm that provides fully balanced, floating action.

HERE IS THE ALL NEW Leslie Reducing Valve with *capacity-regulation* features that have never been offered before. Here is a regulator with 50 - 100% greater capacity by actual test.*

Here's the unbeatable combination of design features:

"HI-FLO" — Large bowl construction; long stroke diaphragm gives full flow of water and other non-corrosive liquids.

FULLY BALANCED — The main valve, fully balanced by lower diaphragm, virtually floats to provide smooth, friction-free, throttling action.

DROP-TIGHT SHUTOFF — Resilient seating disc provides tight closure under all conditions.

TROUBLE-FREE DESIGN — Chatter and hammer eliminated; no piston cups or seals to clog or change. Corrosion resistant trim with renewable interchangeable fit.

Ask your Leslie Engineer to show you how the exclusive Leslie "Hi-Flo" valve can be used to your advantage in water reducing stations, fuel oil pressure control, process lines, etc. He's in your classified directory under "Valves" or "Regulators".

Write today for Bulletin 553 for graphic performance comparison and complete capacity data.

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LESLIE
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REGULATORS AND CONTROLLERS

LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

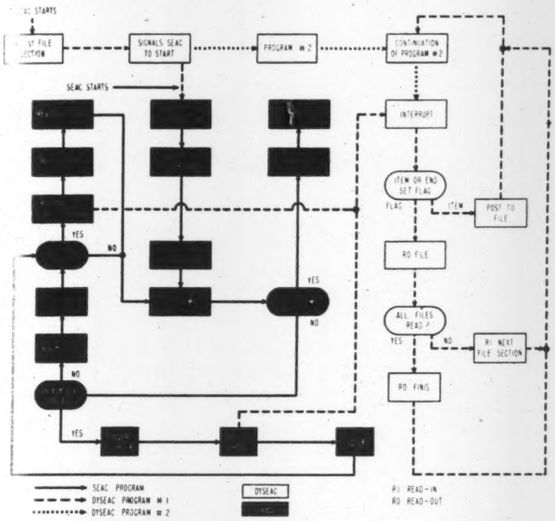
CONTROLLED QUALITY MEANS QUALITY CONTROLS

For more information circle **29** on inquiry card.

Scientific Manpower Commission, which has been comparing our educational and manpower trends with those in Soviet Russia since 1953, again brings interesting statistics which justify its chosen headline "Later Than We Think." In 1946/47, enrollment of engineering students was nearly 13%; in 1950/51 only 7.8% were aiming at an engineering degree in the USA.

DYSEAC and SEAC Cooperate

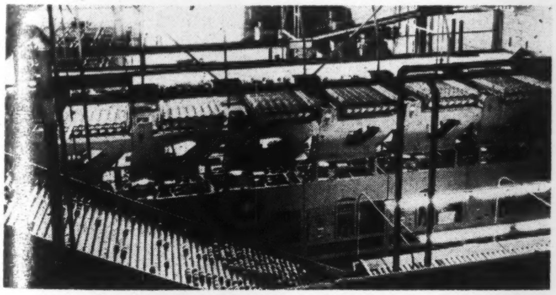
WASHINGTON, D. C.—The National Bureau of Standards successfully has performed experiments where two of its high-speed computers, DYSEAC and SEAC, jointly solved a problem from coordinated-program inputs. Significance of the experiment lies in the fact that digital computers need not have identical operating characteristics to work together. Necessity to use more than one high-speed computer may arise, for instance, for processing the same data for different purposes at different locations.

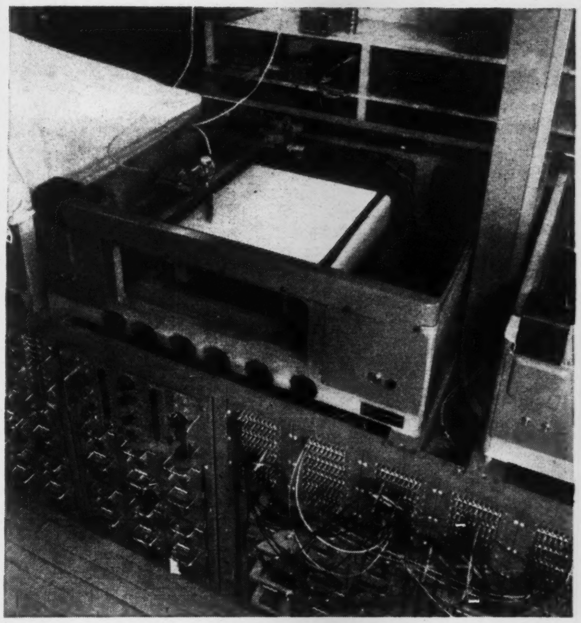


SEAC STARTS
FILE SECTION
SIGNALS SEAC TO START
PROGRAM #2
CONTINUATION OF PROGRAM #2
SEAC STARTS
INTERRUPT
ITEM OR END SET FLAG
FLAG
ITEM
POST TO FILE
YES
NO
RO FILE
YES
NO
ALL FILES READ?
YES
NO
RI NEXT FILE SECTION
NO
RO FINIS
YES
SEAC PROGRAM
DYSEAC PROGRAM #1
DYSEAC PROGRAM #2
DYSEAC
RI READ-IN
RO READ-OUT

Automatic Lemon Sorting

OXNARD, CALIF.—The Somis Lemon Association plant has installed equipment which automatically sorts lemons by colors ranging from dark green to tree-ripe dark yellow. Built by Electric Sorting Machine Co. of Grand Rapids, Mich., it handles the delicate merchandise at a rate of 1,000,000 per day, using phototubes to scan the whole lemon to detect any discoloration.





MIT Function Generator

plots curves on a special Bristol strip chart

The strip chart above was designed and printed by Bristol especially for the MIT function generator.

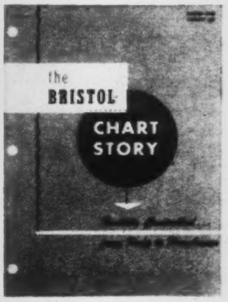
It's one of hundreds of special strip and circular charts Bristol turns out each year to instrument builder specifications.

Why Bristol? Several reasons: We've been printing precision instrument charts for over 65 years, for one thing. We're familiar with instrumentation problems, for another. And, already one of the largest chart printers in the country, we've recently expanded our production facilities and engineering service.

What does this mean to you? It means that at Bristol you can get circular charts up to 12 inches in diameter—strip charts up to 29⅝ inches across. You can get charts for all kinds of special instruments—research, industrial, test, analytical, scientific, laboratory and pilot plant instruments and computors, to name a few. You can get charts printed on wax-coated, heat-sensitive, chemically-coated, electrically-sensitive or other special papers.

What's more, it will pay you to call on Bristol's chart service when your recorder is in the design stage. Put our long experience in designing both instruments and charts to work for you. Write the Bristol Company, 154 Bristol Road, Waterbury 20, Conn.

FREE BULLETIN Y1904 tells how Bristol Charts are made. Write for your copy.



the BRISTOL
CHART STORY

6.17

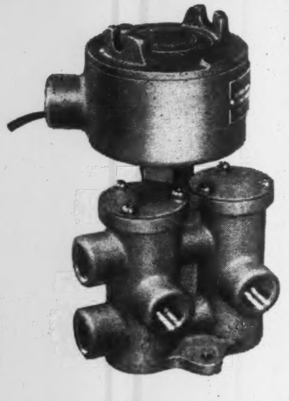
BRISTOL ***Points the Way in Human-Engineered Instrumentation***

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

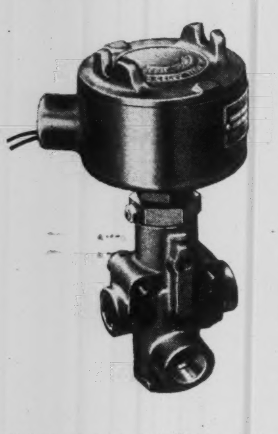
For more information circle **30** on inquiry card.

EXPLOSION-PROOF

Crescent®
Solenoid
Valves



Weight of typical ½" Four-Way Valve is only 9 pounds.



® 4-Way and 3-Way Solenoid operated, pilot controlled valves for Air, Water and light oil to 150 P.S.I., products of Crescent Valve Co.

Weight of typical ½" Three-Way Valve is only 6½ pounds.

NO COIL BURNOUT

because a generous power margin, short solenoid travel and pilot operation combine to prevent overheating and overloading. Note that these valves are accepted and used in ordnance plants where the need for safety and dependability does not permit coil or valve failure.

LONG SERVICE LIFE

Main valve design is aimed at extremely long trouble free service. Resilient seats are tight sealing and are not affected or damaged by dirt or grit because they are of a self scavenging design. Witness their superior performance in the severe service in dusty environment of chemical plants and flour mills.

INTERCHANGEABILITY

Solenoids and pilot sections are interchangeable from one valve size to another, minimizing spare parts requirements. Adaptation to any practical voltage is achieved by a simple coil change.

Speed of response, speed of installation and dependable leak-proof operation year in and year out are responsible for the increasing switch to Crescent valves on production machinery where time is money.

For complete data write for Catalog 6-C.

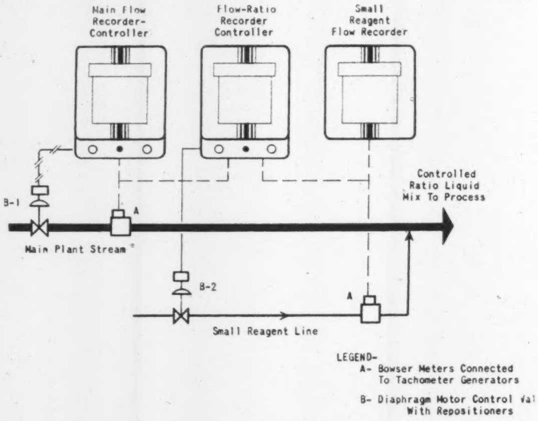
BARKSDALE VALVES

5125 Alcoa Ave., Los Angeles 58, Calif.

For more information circle 31 on inquiry card.

Flow-Ratio Control to 0.1%

PHILADELPHIA, PA.—Rigid specifications by a large Eastern chemical company required the ratio of two liquid flows to be held with an accuracy of 0.5%. A system designed by Leeds & Northrup Co. has met design specifications and is actually metering the two flows with an accuracy of about 0.1%.

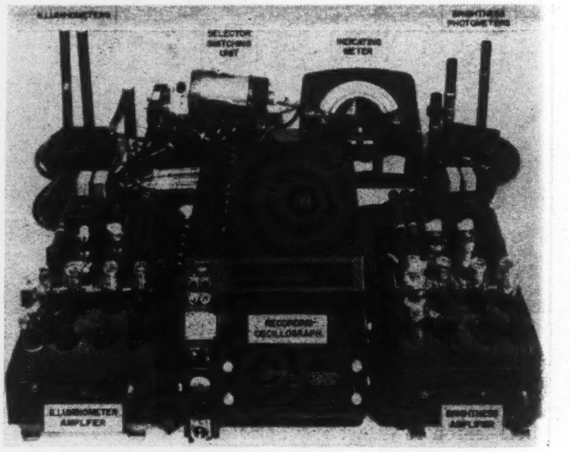

Main Flow Recorder-Controller
Flow-Ratio Recorder Controller
Small Reagent Flow Recorder
Controlled Ratio Liquid Mix To Process
B-1
A
Main Plant Stream
B-2
A
Small Reagent Line
LEGEND-
A- Bowser Meters Connected To Tachometer Generators
B- Diaphragm Motor Control Valves With Repositioners

Using Bowser piston-type positive displacement meters, each fluid flow is converted into rotation of a shaft geared to a tachometer generator. Thus volumetric flow rate is translated into a proportionate electrical analog voltage which is measuerd by L&N Speedomax strip-chart recorders.

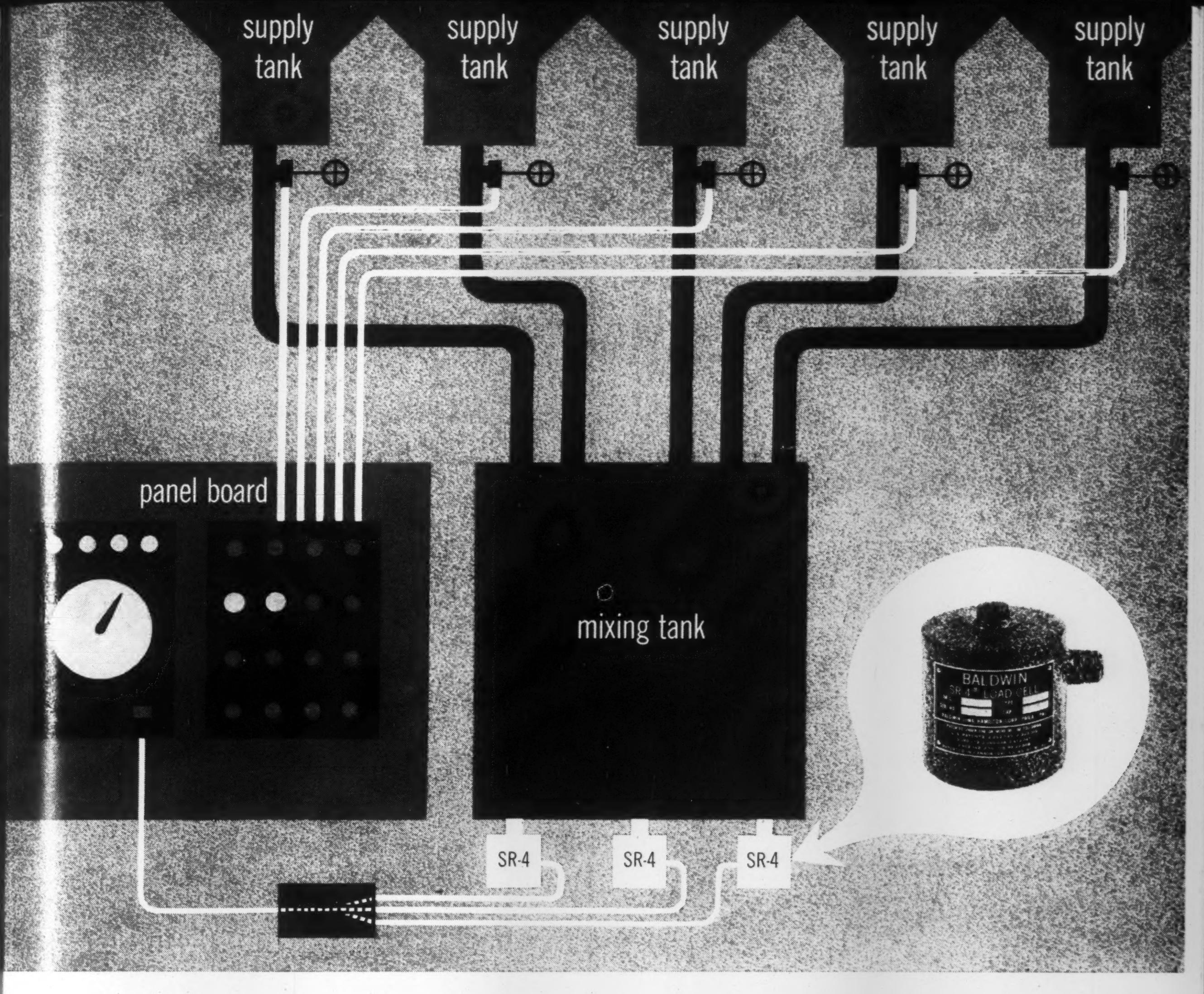
Sky Brightness

PASADENA, CALIF.—Sky brightness does not depend on the sun only; it changes with altitude and atmospheric pressure. Scientists of the Naval Medical Research Institute and Bureau of Aeronautics use a recording oscillograph for instantaneous recording of data taken by other instruments during test flights. Airborne equipment (developed by Consolidated Electrodynamics Corp.) is composed of electronic photometers, a selector switching unit, an amplifier, an indicating meter graduated in light units, and a recording oscillograph.

The signal generated by the photometer is passed through a motor-operated selector switch and an ampli-


ILLUMINOMETERS
SELECTOR SWITCHING UNIT
INDICATING METER
BRIGHTNESS PHOTOMETERS
RECORDING OSCILLOGRAPH
ILLUMINOMETER AMPLIFIER
BRIGHTNESS AMPLIFIER

Circle 32 on inquiry card. →



Baldwin electronic SR-4® system controls chemical process to ±¼% accuracy

Closed loop control of this chemical plant's mixing process is provided by an integrated Baldwin SR-4 system with a maximum degree of accuracy and repeatability.

To add the correct amount of each ingredient, the Baldwin indicator controller automatically opens and closes supply tank valves. The controller receives its signals from three Baldwin SR-4 transducers which weigh each ingredient as it is added to the batch. Load cells install conveniently just below the mixing tank. Baldwin load cells are instantaneously responsive, have no moving parts, require no maintenance. The mixer is timer actuated. Lights on the panel board show cycle stage at all times.

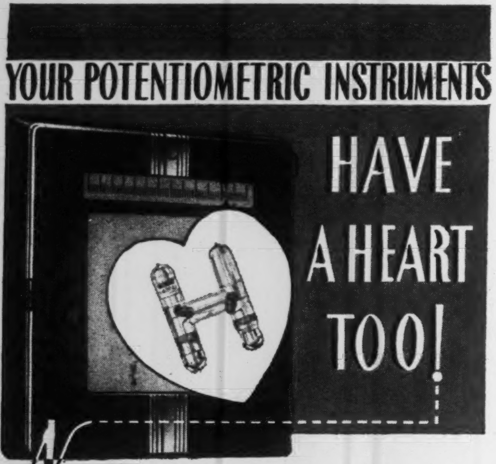
You can have a Baldwin SR-4 electronic control system, specifically designed for your requirements, for any application involving weight, pressure, tension, torque or thrust. We engineer the entire system and calibrate it as a unit, to guarantee you maximum accuracy. For your copy of our general bulletin 4300, write Dept. 2753, Electronics & Instrumentation Division, BLH Corporation, Waltham, Massachusetts.

BALDWIN BLH LIMA-HAMILTON

ELECTRONICS & INSTRUMENTATION DIVISION

BALDWIN-LIMA-HAMILTON

DIVISIONS: Austin-Western • Eddystone • Hamilton • Lima • Electronics & Instrumentation • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works



NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

For more information circle 33 on inquiry card.

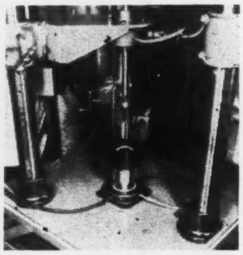
fier effecting logarithmic amplification of the signal. The indicating meter is a modified Weston model 273 voltmeter. The recorder is a CEC Type 5-114, 18-channel recording oscillograph.

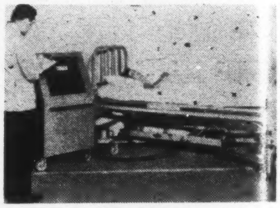
News Bits

ASSOCIATION FOR APPLIED SOLAR ENERGY has started a library comprising more than 2500 references and the few books which exist today on the subject of solar energy.

A COLLINS MICROWAVE System will connect 2 stations, 78 miles apart, to service a crude oil line near Oklahoma City. With 2 relay stations, 375 miles will be tied together. The pump stations thus can be controlled and operated from the end of the line. The present setup includes 5 channels for administrative, dispatching, communication, equipment servicing, and remote control.

MINNEAPOLIS-HONEYWELL is said to be the first to use a sapphire rod as temperature-sensing unit to control the growing of silicon crystals for transistors, a delicate operation.


M-H transistor production.


Baldwin SR-4 Load Cells used in portable scale.

BALDWIN SR-4 load cells in a portable electric scale setup now weigh hospital bed patients without disturbing them.

YARDNEY INTERNATIONAL affiliates from seven nations recently gathered in Paris for a conference on lightweight storage batteries used in aircraft, missiles, etc.

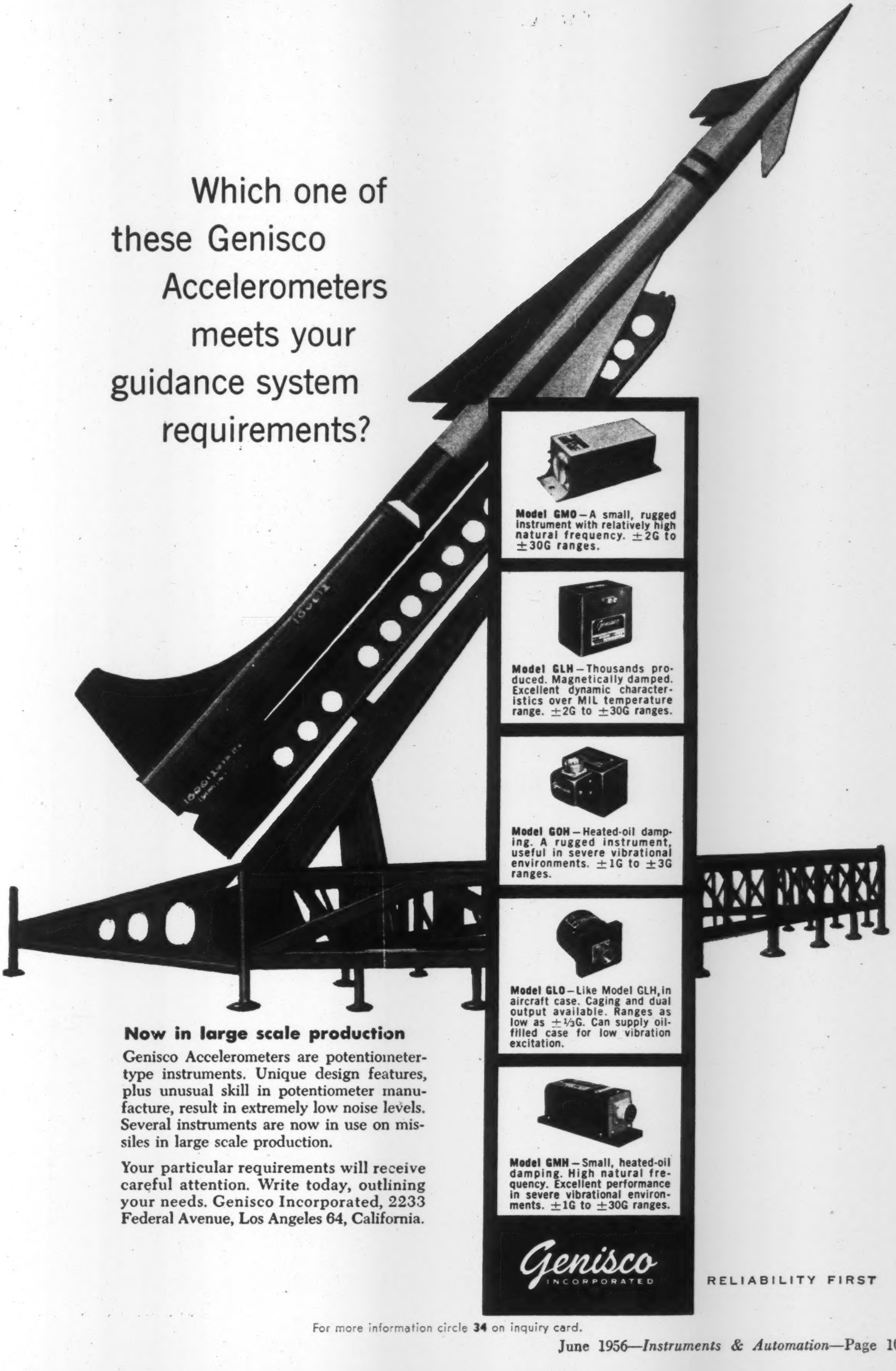
BECKMAN Model 150 RF Gas Analyzers' high sensitivity to hydrocarbon gases, and its selectivity have proved 90 percent effective in Hycalog's Shreveport oil-well logging operations. Risk of drilling dry holes is greatly reduced.

PRINTED CIRCUIT CLINIC held in Cincinnati in April was attended by 100 representatives of electronic industries.

CONSOLIDATED ELECTRODYNAMICS has delivered a custom-built mass spectrometer to Carboloy Department of General Electric to analyze gases produced in a high-vacuum furnace in which alloys are made.

ASTM AIR POLLUTION test methods, recommended practice for sampling, and definitions related to air pollution measurements have been published in Part 7 of the 1955 Book of ASTM Standards.

NATIONAL BUREAU OF STANDARDS has developed an electronic tracking device that automatically follows the position of a metallic object inside an enclosure



Which one of these Genisco Accelerometers meets your guidance system requirements?

Model GMO—A small, rugged instrument with relatively high natural frequency. ±2G to ±30G ranges.

Model GLH—Thousands produced. Magnetically damped. Excellent dynamic characteristics over MIL temperature range. ±2G to ±30G ranges.

Model GOH—Heated-oil damping. A rugged instrument, useful in severe vibrational environments. ±1G to ±3G ranges.

Model GLO—Like Model GLH, in aircraft case. Caging and dual output available. Ranges as low as ±1/3G. Can supply oil-filled case for low vibration excitation.

Model GMH—Small, heated-oil damping. High natural frequency. Excellent performance in severe vibrational environments. ±1G to ±30G ranges.

Now in large scale production

Genisco Accelerometers are potentiometer-type instruments. Unique design features, plus unusual skill in potentiometer manufacture, result in extremely low noise levels. Several instruments are now in use on missiles in large scale production.

Your particular requirements will receive careful attention. Write today, outlining your needs. Genisco Incorporated, 2233 Federal Avenue, Los Angeles 64, California.

Genisco
INCORPORATED

RELIABILITY FIRST

For more information circle **34** on inquiry card.

engineers
physicists

Leeds and Northrup Company wants to talk with you about Engineering openings in:

- **application**
- **sales marketing**
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For over 50 years Leeds & Northrup has been the world's foremost manufacturer of Automatic Process Control and Scientific Electrical Measuring Instrumentation.

If you are seeking stability of employment, favorable salary schedules, unusual advancement opportunities plus other employee benefits commensurate with these high standards, write us today.

Build on your past experience in any of these fields:

★ **Electrical Measurement & Control of Industrial Processing**
★ **Power Generation & Transmission**
★ **Servo Mechanism**
★ **Digital & Analog Computers**
★ **Combustion Control**
★ **Nuclear Reactors**

Write for Details to—

Technical Employment Division

LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE
Philadelphia 44, Pa.

of non-conducting material. Probe, containing mutual inductance transducer, detects motion of object without physical contact.

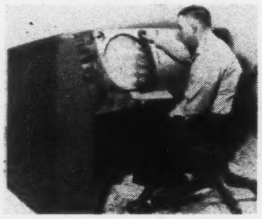
CIVIL AERONAUTICS ADMINISTRATION will modernize the Federal air traffic control system by a 5-year program designed to keep pace with the requirements of the jet age.

AEC REACTOR TRAINING SCHOOL will train 62 students, including 47 from 23 foreign nations and 15 from the U.S., in the third session of the School of Nuclear Science and Engineering operated for the Commission by the Argonne National Laboratory nea Chicago.

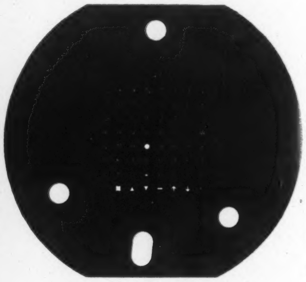
LINK AVIATION is building a jet aircraft simulato for United Airlines which will precede production an delivery of the new DC-8 plane itself. Use is in preliminary training of crews.

STROMBERG-CARLSON, a division of General Dynamics Corp., has completed a transistorized all-electroni dial telephone switchboard which uses no vacuum tube or mechanical stepping switches. It was delivered to th Bureau of Ships of the U. S. Navy.

BOSTON ELECTRONICS Div. of American Machin & Foundry has developed a special cathode-ray-tube display for presenting information pertaining to an aircraf traffic situation. Equipment is electronic equivalent o manually operated plotting boards.



Boston CRT plotting board



Gurley Matrix

W. & L. E. GURLEY, Troy, N. Y. is producing matrices for use in Hughes Aircraft Co.'s Typotron tubes. Letters and characters are formed on face of tube at rat of 25,000 characters per second.

MINNEAPOLIS-HONEYWELL's aeronautical division will provide a self-contained three-axis guidance system for the satellite in Project Vanguard.

1st Quarter Reports

Hoffman Electronics Corp.—$12 million sales, 35% increase over 1st Qtr. 1955.

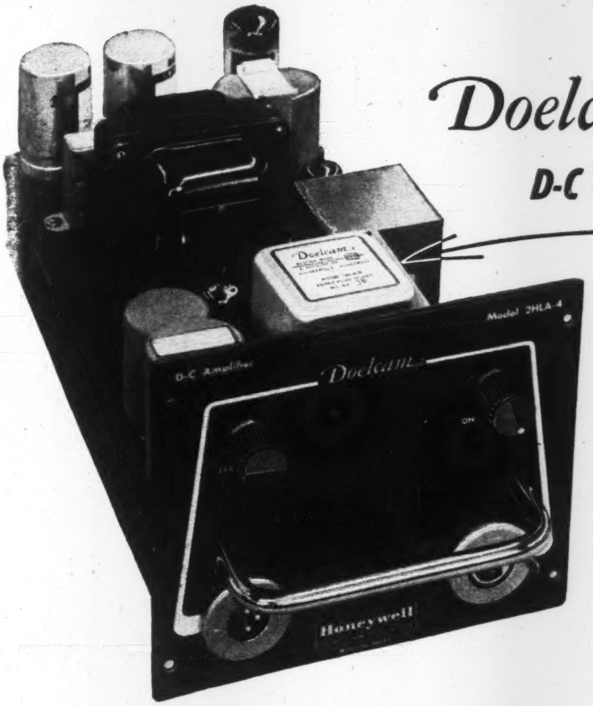
Square D Co.—$23 million sales, 44% increase ove 1st Qtr. 1955.

Walworth Co.—$20 million sales, 90% increase ove 1st Qtr. 1955.

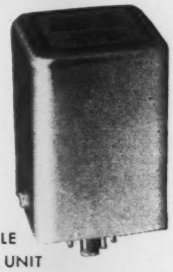
Clevite Corp.—$18 million sales, $2 million over 1s Qtr. 1955.

American Bosch Arma Corp.—$25 million sales, $ million over 1st Qtr. 1955.

Doelcam Selective Range
D-C PROPORTIONAL AMPLIFIER



MODEL 2HLA-4
Shown with Cabinet off for Rack Mounting



INTERCHANGEABLE
RANGE PLUG-IN UNIT

Available in any range between
0 to 0.1 MILLIVOLT
and
0 to 100 MILLIVOLTS

SPECIFY AN INTERCHANGEABLE PLUG-IN UNIT THAT MEETS YOUR RANGE REQUIREMENT . . . *EXACTLY*

The Doelcam Selective Range D-C Amplifier Model 2HLA-4 is designed for use in the laboratory or production line as a component part of a control or linear measuring system. It will accept any one of a number of interchangeable Range Plug-In Units for the combination of input voltage range, input resistance and frequency response that meets your application requirements. . . . *exactly*. One Plug-In Unit is provided with each instrument. No need to pay for built-in voltage ranges which may never be used. The exclusive Doelcam Second Harmonic Magnetic Converter is used in the input stage in place of a mechanical chopper for all around improved performance. *Write for Bulletin SRA-4.*

PERFORMANCE CHARACTERISTICS

ISOLATED INPUT: *Input Terminals are isolated from amplifier circuitry and chassis ground.*

HIGH CONVERTER FREQUENCY: *2500 cps carrier, insensitive to 60 or 120 cps pickup.*

LOW DRIFT: *Less than 5 microvolts long term drift.*

LINEAR AMPLIFICATION: *Better than 1% on all ranges.*

GAIN: *Up to 10^5.*

FREQUENCY RESPONSE: *Up to 40 cps.*

RUGGEDNESS: *Withstands over-range signals up to 1500 times full scale.*

HIGH POWER OUTPUT: *Drives most commercial Pen Motors or Galvanometer Recorders.*

MODEL 2HLA-4
Shown with Cabinet on for Bench Mounting.

Doelcam
A DIVISION OF MINNEAPOLIS-HONEYWELL

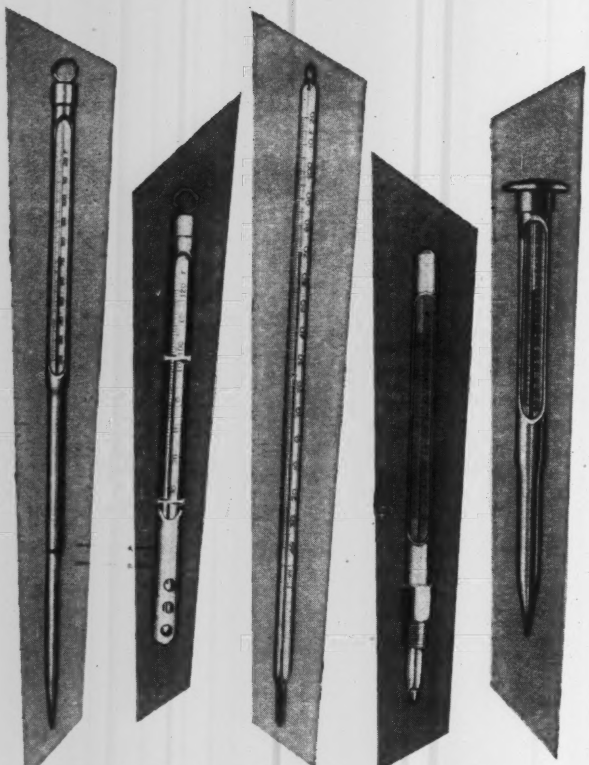
H
HONEYWELL

1400 SOLDIERS FIELD ROAD
BOSTON 35, MASSACHUSETTS

Instruments for Measurement and Control

Synchros • Gyros • Accelerometers • Amplifiers • Microsyns • Servo Motors

For more information circle **35** on inquiry card.



YOU GET

dependability PLUS

WITH MOELLER TEST THERMOMETERS

because our business is the design and manufacture of temperature measuring instruments—and has been since 1867.

Moeller Test Thermometers are guaranteed for permanent accuracy and are made according to specifications set forth by the United States Government, A.S.T.M., and other Societies and Associations.

Mail the coupon today for descriptive literature on Moeller Test Thermometers.

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INSTRUMENT COMPANY
132nd ST. and 89th AVE.
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

Gentlemen: Without obligation, please send me Catalog No. 800 on Moeller Test Thermometers, Hydrometers, Temperature and Hydrometer Conversion Tables.

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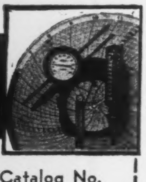
FIRM ....
ADDRESS ....
CITY .... ZONE .... STATE ....

For more information circle **36** on inquiry card.



NEWS—CONTINUED

Thomas A. Edison, Inc.—$9.8 million sales, 11% increase over 1st Qtr. 1955.

TelAutograph Corp.—$1.5 million sales, almost double 1st Qtr. 1955.

Magnavox Co.—$18 million sales, $4 million over 1s Qtr. 1955.

Burgess-Manning Co.—$.8 million sales, $350,00 over 1st Qtr. 1955.

1955 Reports

Servomechanisms, Inc.—1955 sales, $12 million.

Servo Corp. of America—1955 sales, $4 million.

Minneapolis-Honeywell Reg. Co.—1955 sales, $1 million.

High Voltage Engrg. Corp.— 1955 sales, $2 million.

Stock Report

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York

New York Stock Exchange:

	Price Range for 1956 Thru April 30		As of April 30
Security	High	Low	Last
Aeroquip Corp.	14 3/8	11 7/8	13 1/4
American Chain & Cable	46	38 1/2	42 5/8
American Mach. & F.	31 1/8	24 1/8	30 3/4
American Mach. & M.	40 3/4	35 1/8	39 5/8
American Optical	40 3/4	35 1/2	38 3/4
Beckman Instruments	31 1/2	25 1/8	27 3/4
Bell & Howell	40 1/4	28 1/4	40 1/4
Bendix Aviation	62 3/4	49 1/4	60
Bulova Watch	23	20 1/2	20 3/4
Burroughs	38 3/4	28 1/2	38 3/8
Clevite	24 1/4	20 1/8	20 1/4
Dobeckmun	39 1/4	31 3/4	36
Gamewell	30 5/8	25 5/8	28 1/4
General Inst.	10 1/8	8 1/2	8 3/4
General Prec.	53 1/2	44 5/8	45 3/8
General Time	33 1/8	29 1/2	32 1/2
Hamilton Watch	25	19	23 - 23 1/2 (1)
International Business Mach.	534	373	530
Minneapolis-Hon.	78 3/4	58	74 1/2
National Cash Reg.	45	34 1/8	44 1/4
Radio Corp.	50 3/8	41 1/8	46 1/4
Raytheon	19 1/2	15 3/4	16 5/8
Robertshaw-F.	28 3/8	25	26 3/8
Sangamo Electric	37 1/2	29 1/2	35 1/2
Sperry Rand	29 1/8	24	26 3/8
Square D	74 1/2	51 1/2	67
Starrett, L.S.	52 3/4	43 3/4	52 1/2
Sylvania Electric	54 3/4	42	53 3/4
Telautograph	35	29	29
Texas Inst.	14	11 5/8	12 7/8
Underwood	44	35	37 3/4

(1) Bid - Asked price, no sale.

American Stock Exchange:

	Price Range for 1956 Thru April 30		As of April 3
Security	High	Low	Last
Air Assoc	13 1/2	9	10 1/2
American Meter	41	37	38
Benrus Watch	10 3/8	9 3/8	9 5/8
Breeze Corp.	9 1/8	6 5/8	7 7/8
Consolidated Electrodynamics	27 7/8	21	24 3/4
DuMont Labs.	10	7 3/4	7 3/4
ElectroData	20	13 1/2	18 3/4
Fairchild, C. & I.	24 3/8	19 1/2	23
Int'l Resistance	8 1/4	6 3/4	7 1/8
Lear Inc.	10 1/4	8 1/8	9 1/8
Nat'l Res. Corp.	29	17 7/8	29
Neptune Meter	34 7/8	28 3/8	31 1/4
New Haven Clock	2 1/2	2	2
Norden-Ketay	14 7/8	11 1/2	11 1/2
Pneumatic Scale	28 1/4	25 1/2	26 1/2
Servomechanisms	9 1/2	8 1/4	8 7/8
Wallace & Tiernan	22 1/2	20	20 1/4
Waltham Watch	3	1 7/8	2 1/8

BALANCE
OFF
INPUT
INPUT
decker

High Sensitivity Micro-Differential

PRESSURE METER

Completely Self-Contained

no accessories required

Measures

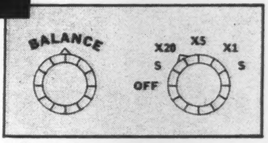
A WIDE RANGE OF **STATIC & DYNAMIC** pressure of gases and other non conducting fluids. Includes provisions for oscilloscope viewing and recording on an optical oscillograph or a direct writing recorder.

Determines

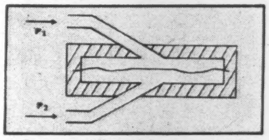
VARIATIONS OF **PRESSURE, VOLUME** temperature, fluid flow, expansion, absorption, adsorption, chemical alterations, altitude, vacuum, etc.

Provides

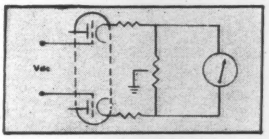
ONE MICRON OF MERCURY **RESOLUTION** at any ambient pressure up to 2 atmospheres. 7.5 volts output available for recording at full scale differential pressure of 1 mm of mercury.



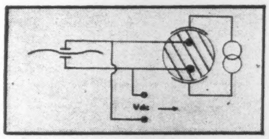
Two-knob control for balance, . . . sensitivity.



Pressure differential moves beryllium-copper diaphragm.



Output applied to cathode follower to drive meter.



T-42 Ionization trandsducer converts motion into electrical signal.

Utilizes the T-42 IONIZATION TRANSDUCER

This unusually simple pressure instrument is completely self contained. It requires no special accessories, additional equipment or trained personnel for operation. Merely plug this compact instrument (only 5" x 5" x 10") into the 115 V, 60 cy. line and in 2 minutes it is ready for use. Two knob control . . . for balance and sensitivity.

It is an extremely versatile and truly valuable accessory for any laboratory.

Details on this new micro-sensitive meter are in Instrument Data Sheet 303-1, available upon request to Technical Literature Section.

decker AVIATION CORPORATION

1361 Frankford Ave., Philadelphia 25, Pa., PHONE GArfield 5-2300

For more information circle **37** on inquiry card.

RESEARCH IS ALWAYS ON

- in fatigue life
- materials • new uses
- production methods

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BRISTOL
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THE WALLACE BARNES CO., LTD.
HAMILTON
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DIVISIONS OF ASSOCIATED SPRING CORPORATION
COAST TO COAST

Divisions of
ASSOCIATED SPRING CORPORATION

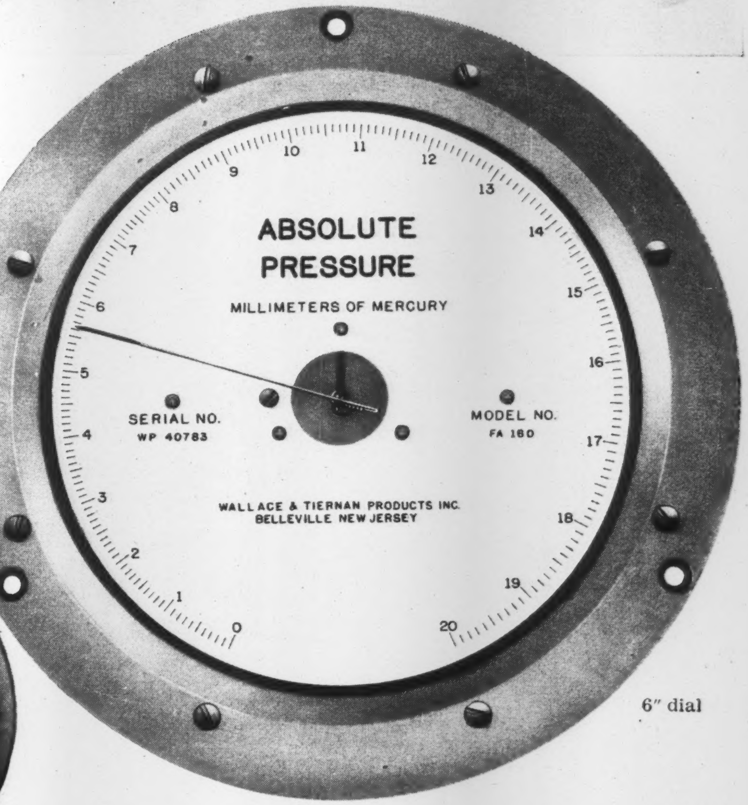
For more information circle **38** on inquiry card.

ABSOLUTE PRESSURE INDICATOR

. . . FOR DEEP VACUUM WORK

**Measures *pressure*
directly from
ZERO ABSOLUTE
to atmospheric**

. . . swiftly and precisely


ABSOLUTE
PRESSURE
MILLIMETERS OF MERCURY
SERIAL NO.
WP 40783
MODEL NO.
FA 160
WALLACE & TIERNAN PRODUCTS INC.
BELLEVILLE NEW JERSEY

6″ dial

ABSOLUTE
PRESSURE
MM
MERCURY

2¾″ dial

TYPE FA-160

Used as a pressure indicator in any system employing a vacuum.

- All readings are relative to ZERO ABSOLUTE.
- Dial *reads directly.*
- Accurate to 1 part in 300 over full scale.
- Sensitive to 1 part in 500 in *all* ranges.
- No auxiliary indicator or corrections for ambient pressure changes required.
- Protected against sudden pressure surges.
- Ranges:
  0— 50mm Hg. 0—410mm Hg.
  0—100mm Hg. 390—800mm Hg.
  0—200mm Hg. 0—800mm Hg.
- Dial Sizes: All ranges in either 2¾″ or 6″ dia.

*or additional information on
&T Absolute Pressure Indicators,
rite today for Publication No. TP-28-A.*

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST., BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

A-102

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...the universe and UNIVAC®

Science has unlocked a vast new frontier — the limitless areas of space, man's most daring and intriguing exploration yet. Leading in the race to conquer these new worlds are American scientists and engineers . . . descendants of the "not-so-long-ago" pioneers who developed our great country.

The scientists and engineers at Remington Rand Univac are leading the field and are part of the team that is setting "*new* standards for others to follow."

Because of these great new opportunities many openings have been created at our laboratory at South Norwalk, Connecticut. Here the most modern facilities and equipment are available for your use. You will be living in a charming Connecticut town located on Long Island Sound. Here recreation and social activities continue on a round-the-year basis and there are excellent education facilities for your children.

At South Norwalk we have immediate openings for Mechanical and Electro-Mechanical Engineers with a bachelor's degree in *Engineering*. Extensive mechanical design background may substitute for some college. Men selected will do basic preliminary design and layout of small mechanisms. Work will require the development of original ideas and the ability to apply logical analysis to design problems.

Send complete resumé to

Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION
Attention Mr. A. L. Crable
Wilson Avenue • South Norwalk, Connecticut

® Registered in U. S. Patent Office

New Plants and Mergers

MINNEAPOLIS-HONEYWELLL announces plans to transfer its Transistor Division to Boston.

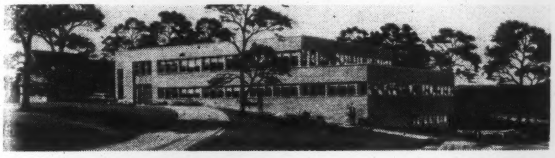
AMERICAN PHENOLIC CORP., Chicago, announces stockholder approval that changes its name to Amphenol Electronics Corp.

GENERAL ELECTRIC CO., Waterford, N. Y., announces acquisition of 60 acres adjacent to Silicone Products Dept. for expansion of production, research and administration facilities to meet increasing demands for silicones.

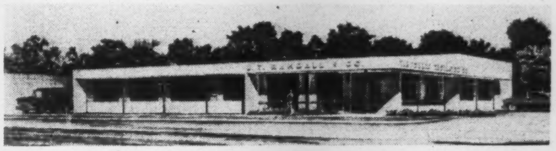
INTERNATIONAL TELEMETER CORP., announces formation of Telemeter Magnetics, Inc., for development and production of special-purpose data processing machines, memory components, modular electronic components for data handling, and high-speed automatic core testing equipment.

BECKMAN INSTRUMENTS, INC., Fullerton, Calif., announces formation of a new Data and Control Systems Dept. primarily interested in linking instrumentation with digital computers.

GENERAL PRECISION LABORATORY INC. announces ground-breaking for a new Environmental Test Laboratory at Pleasantville, N. Y.



POWERS REGULATOR CO., Skokie, Ill., announces construction of two new office-warehouse buildings. One, an 11,000 sq. ft. office, located in Detroit, will be occupied by D. T. Randall & Co., agents. Houston quarters will be replaced by a 2,000 sq. ft. structure.

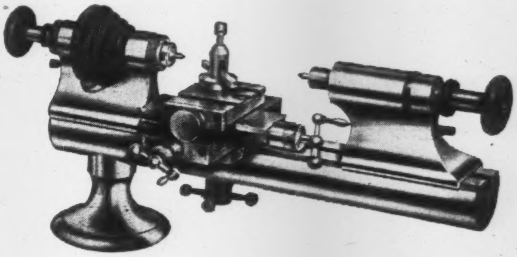

D. T. RANDALL & CO.

DU MONT LABS., Clifton, N. J., announces new Industrial Tube Sales Dept. devoted solely to sales of industrial cathode-ray tubes and multiplier phototubes.

BAIRD ASSOCIATES, INC. announces a merger with Atomic Instrument Co. The new company will be known as Baird Associates-Atomic Instrument Co.

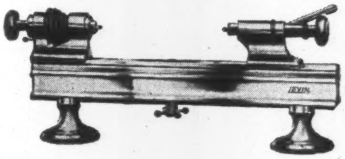
LEAR, INC., continuing its plant expansion program, is adding a two-story wing to the hanger housing the Aircraft Engineering Division, and a 14,000 sq. ft. addition

ARE YOU DRIVING TACKS
WITH A
SLEDGE HAMMER?

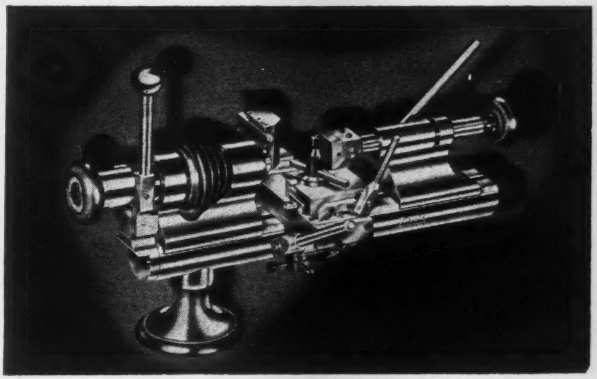


SMALL PARTS ARE MADE WITH GREATER ACCURACY • ECONOMY • SPEED
ON LEVIN INSTRUMENT LATHES

For efficiency small work should be done on a small lathe. In many cases the work done on an instrument lathe requires a degree of precision and fine finish which cannot be obtained from larger machines. LEVIN lathes are made in two collet capacities, 5/16″ or 3/16″, and thirty-three different models.



Send for Catalog M describing complete line of instrument lathes and accessories. Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, California.



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How you Can Save Time Measuring Surface Temperatures in Your Plant with

ALNOR PYROCONS

The Alnor Pyrocon combines laboratory precision with production tool ruggedness to give you fast, accurate answers to *all* surface temperature problems. It takes just 3 seconds to give you the temperature of any surface...regardless of shape or material...revolving or stationary. And the heavy, shock-resisting movement is housed in a balanced unit that's compact, easy to handle.

Mail this ad with your business letterhead to Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **41** on inquiry card.

VIBRATION METER

measure vibration anywhere

CEC's 1-128 vibration meter

Here's new ease in tracking down and measuring mechanical vibration . . . CEC's new 1-128 *all-transistor* Vibration Meter. It contains its own power source, can be operated anywhere. Using standard CEC self-generating pickups, the meter indicates vibration *directly* as mils peak-to-peak displacement.

Frequency range . . . 10 to 1000 cps
Sensitivity . . 0.0005″ peak-to-peak displacement provides full-scale indication from 50 to 1000 cycles.
Temperature range . . . −20°F to +120°F
Power source . . . two standard 22½-volt batteries
Size and weight . . . 7½ x 5½ x 3⅜″; 7½ lbs., with batteries

For complete information, send today for Bulletin CEC 1566-X8.

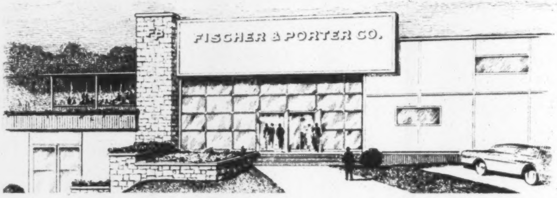
Consolidated Electrodynamics
CORPORATION
formerly Consolidated Engineering Corporation
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena California

For more information circle **42** on inquiry card.

to the Lear-Romec Division at Elyria, Ohio, and plans to construct an ultra-modern 170,000 sq. ft. manufacturing plant at Grand Rapids (Mich.) Airport, providing manufacturing facilities of maximum efficiency for Lear's Grand Rapids Division.

TEXAS INSTRUMENTS INC., Dallas, announces transfer of production and marketing of recording instruments from Dallas to Houston Technical Labs., Houston 6, Texas; and plans for a new semiconductor plant slated for fall groundbreaking.

FISCHER & PORTER has broken ground for a new million-dollar office building which will release floor space in the plant, permitting expansion of all manufacturing facilities.

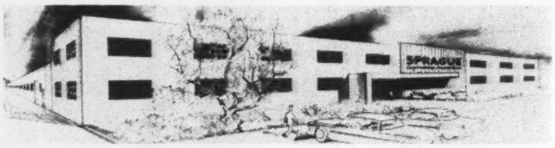

FISCHER & PORTER CO.

AUTOMATIC ELECTRIC CO. announces ground-breaking for their new headquarters plant, part of a multimillion dollar expansion program.

NUCLEAR CORP. OF AMERICA, INC. announces acquisition of Isotope Specialties Co., Burbank, Calif., in exchange for 47,991 shares of Nuclear's Class A stock.

GENERAL ELECTRIC CO., Schenectady, N. Y., announces unveiling of their new $7 million factory that reduces production time on 7-30 hp motors from two weeks to 24 hrs.

SPRAGUE ENGINEERING CORP. has started construction on a new factory and office building in Gardena, Calif., that will centralize operations now carried on at five leased buildings.



STROMBERG-CARLSON DIV., GENERAL DYNAMICS CORP., announces opening of a new main plant in San Diego, Calif.

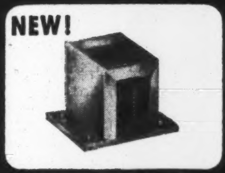
INTERNATIONAL RESISTANCE CO. announces merger with three wholly-owned subsidiaries: Hycor Co., Inc., Hycor Sales Co. of Calif., and Ircal Industries.

INTERNATIONAL DIVISION, BECKMAN INSTRUMENTS, INC. has assumed exporting responsibility of all manufacturing divisions, including the Arga and Helipot Divisions, Berkeley, Spinco, Liston-Becker and the Scientific Instruments Division.

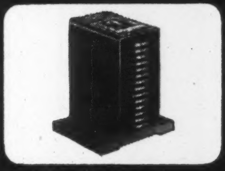
J. B. REA CO., INC. announces plans to add a 40,000 sq. ft. production facility to the existing 22,000 sq. ft. office and plant, Santa Monica, Calif.

FISHER GOVERNOR CO. announces purchase of Control Specialty Corp., Houston, which will operate as a Fisher subsidiary.

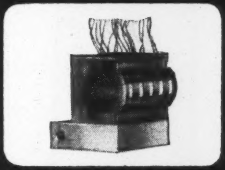
BYRON JACKSON ELECTRONICS DIV., Borg-Warner Corp. has received a one million dollar Air Force contract for manufacture of signal generators.



BK-3300, BK-3500, BK-3700—ultimate in precision made multichannel heads.

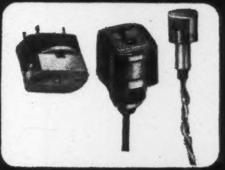


BK-1300, BK-1500 series—up to 25 interlaced channels per inch.



BK-1605 series—simple mounting and adjustment, ideal for drum computers.

BK-1501 series—compact, wafer-thin, permit individual adjustment.



BK-900, BK-1000, BK-1200 series—variety of types for single channel applications.

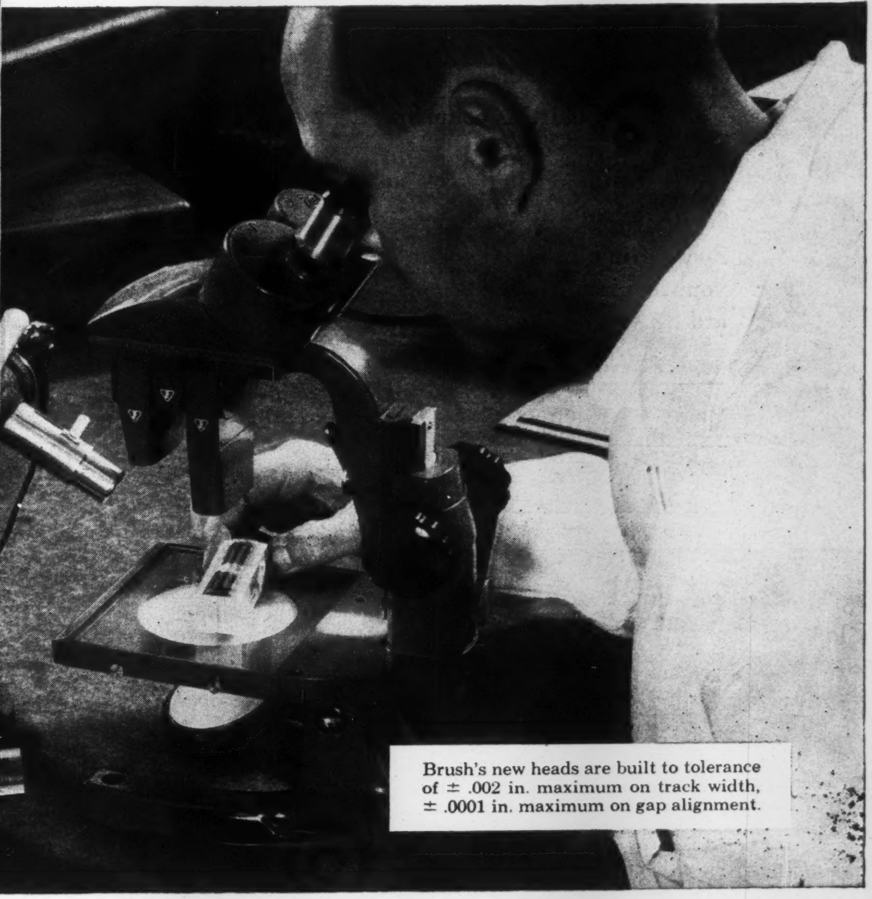
How Brush Magnetic Heads improve product performance

Microscopic inspection is a familiar tool in Brush's manufacturing of magnetic heads. Track width and gap alignment must be held to ten-thousandths; pole faces and tips must be lapped to a surface finish of better than 8 microinches.

This craftsmanship improves product performance. Precision gap alignment assures perfect time phase accuracy. Close tolerances permit greater pulse packing, increased storage capacity, uniform output and frequency response.

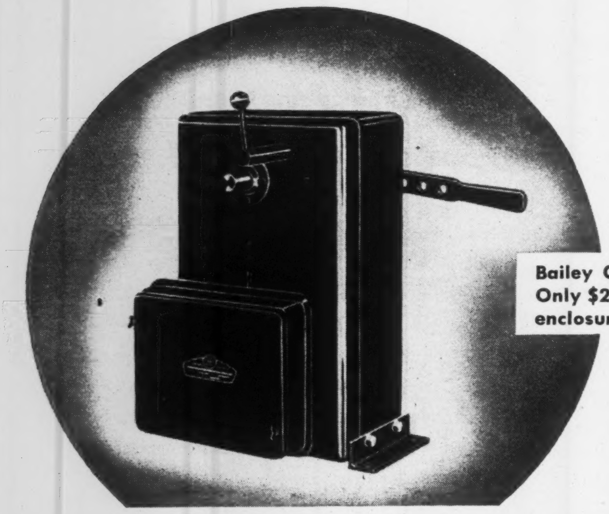
Get the facts on Brush's complete line of magnetic heads, including the new precision multichannel heads. Write Brush Electronics Company, Dept. A-6, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS BRUSH ELECTRONICS **COMPANY**
3405 Perkins Avenue, Cleveland 14, Ohio
DIVISION OF
CLEVITE CORPORATION



Brush's new heads are built to tolerance of ± .002 in. maximum on track width, ± .0001 in. maximum on gap alignment.

For more information circle **43** on inquiry card.



Bailey Control Drive, Type AC44P Model 200. Only $210.00 F.O.B. Cleveland, complete with enclosure, positioning relay and hand operator.

Want Better Flow Characteristics from Your Regulating Devices?

This new, small, piston-operated Bailey Control Drive will improve the flow characteristics of butterfly valves, dampers, hydraulic couplings, feeders and similar regulating devices. Adjustment is simple; any desired relation between drive motion and pneumatic signal may be secured.

You can install this compact pneumatic drive power unit in any position on a column, pipe, or flat surface—and connect it to the regulating device with standard Bailey linkage, available from stock.

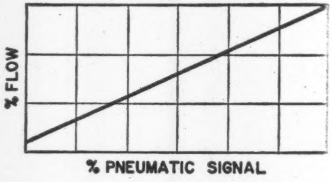
Speed (time required for full travel) is adjustable to suit your requirements. Bailey Control Drives operate on standard SAMA pneumatic signal ranges of 3 - 15 or 3 - 27 psig.

AVAILABLE FROM STOCK in 3 standard sizes

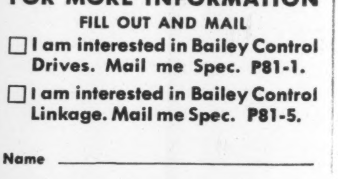
Type	Piston Dia. Inches	Piston Stroke Inches	Torque ft-lb	Max. Travel Degrees	Approx. Dimensions Inches
AC816	8	16	1500	90	13 x 27 x 51
AC68	6	8	400	90	13 x 19 x 34
AC44	4	4	75	75	10 x 11 x 19

P-28

The New Bailey Control Drive gives you THIS—



instead of THIS



BAILEY
METER COMPANY
1041 IVANHOE ROAD
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Complete Controls for Process Plants

BAILEY METERS

Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO

FOR MORE INFORMATION
FILL OUT AND MAIL

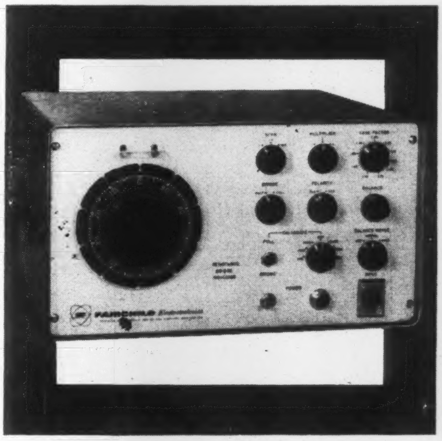
☐ I am interested in Bailey Control Drives. Mail me Spec. P81-1.
☐ I am interested in Bailey Control Linkage. Mail me Spec. P81-5.

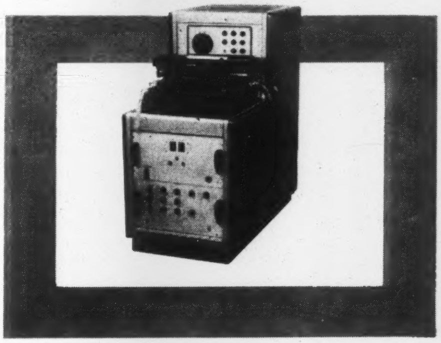
Name ____________________
Title & Company ____________________
Street & Number ____________________
City & Zone ______________ State ________

For more information circle **44** on inquiry card.

NEW

AUTOMATION PACKAGES FOR RESEARCH—FOR INDUSTRY
TO MEASURE—CONTROL—RECORD : **PRESSURES**
STRAINS
TEMPERATURES
LOADS
DEFLECTIONS





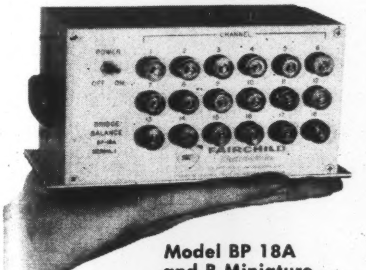
Fairchild Electrotechnics now has the answer for your specific automation needs with the precision measuring components, the reliable standard systems, and the custom systems your projects or your plant require. Check their specifications. See how these elements—single units, building blocks or complete automatic instrumentation systems—fit into your testing, your production picture.

Model 101B Resistance Bridge Indicator (RBI)

A self-balancing, accurate and compact instrument measuring output of resistance bridge transducers such as strain gages, accelerometers, pressure, position, and force pickups and resistance thermometers. Quantities measured can be read-out directly; dial can be set to read to microin./in., psi., lbs., degrees, etc. Voltage supply for bridge power is self-contained. Accuracy is independent of supply voltage variations—no standardization required.

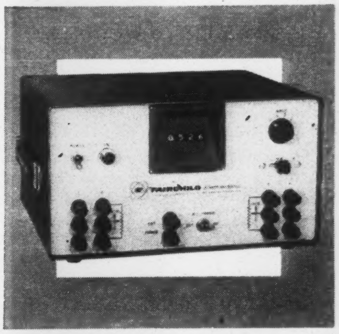
- Input: Full or half bridges, 50 to 1000 ohms resistive
- Output: Self-balancing, 10-turn dial indicator reads directly in units being measured
- Sensitivity: Measures resistance changes from 0.0002% to 8%
- Accuracy: 0.25%—independent of supply voltage variations
- Linearity: 0.1%
- Zero Drift: 0.25% per hour maximum, on highest sensitivity scale
- Response time: 4 secs. for 10-turn, full scale

Variations of this model can be made to deliver multi-channel automatic transcription of data. In an RBI system of this kind, the indicator, or units, drive a typical, commercially-available analog-to-digital decimal and binary converter; data is then transcribed on printers or electric typewriters, or tape and card punch devices. More sophisticated RBI systems, such as the model FRG shown in the above inset, are capable of scanning and recording automatically 100 channels of data . . . can be applied to automatic checkout, plotting, control and rejection functions.



Model BP 18A and B Miniature Bridge Balances

hese precision instruments provide ectrical balance, sensitivity control d calibration of resistance, D. C. idge circuits such as strain gages, essure pickups and accelerometers. ach unit is capable of controlling 8 separate full bridge channels; each atures the same accuracy and ggedness found in much larger boratory models.



Model 301B Voltage Ratio Indicator

A self-balancing instrument for comparing two related D. C. voltages in ratios from 0 to 100%, and for measuring resistance ranging from 100 to 10,000 ohms. It is ideal for calibration and inspection of pickups and transducers used in direct recording telemetering systems. A digital display indicates voltage ratio and resistance measurements. Self-contained voltage supply furnishes power to the source if desired. Accuracy is independent of supply voltage variations; no standardization required.

For additional information, write us stating specific automatic instrumentation problem.

FAIRCHILD *Electrotechnics*
DIVISION OF FAIRCHILD ENGINE AND AIRPLANE CORPORATION
118 East 16th Street • Costa Mesa, California

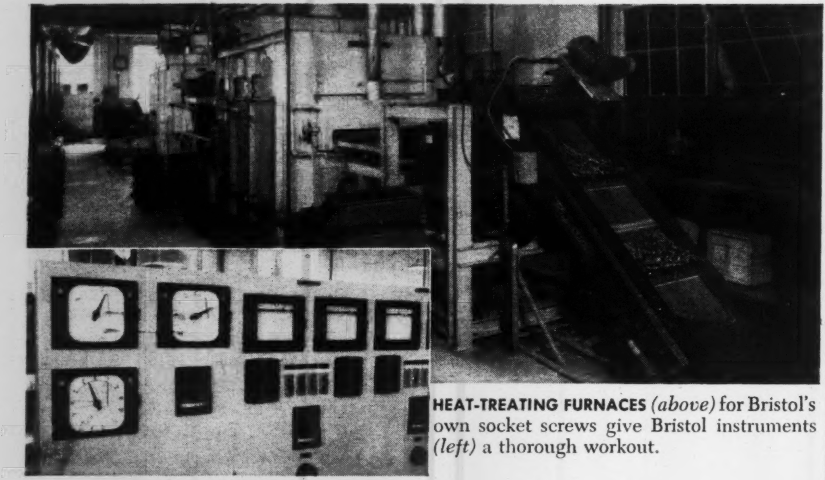
For more information circle **45** on inquiry card.

BRISTOL'S

Instrumentation News

• News of instrumentation and automatic control in industrial heating and metallurgy •

New instruments pass tough "field" tests at home



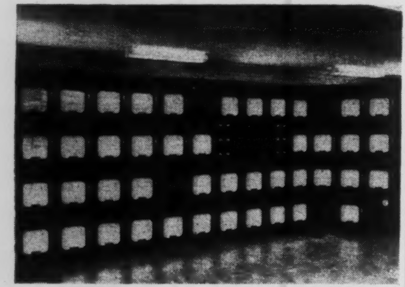
HEAT-TREATING FURNACES *(above)* for Bristol's own socket screws give Bristol instruments *(left)* a thorough workout.

New Bristol instruments for metal-treating operations have a ready-made proving ground in Bristol's own socket screw manufacturing division.

Bristol instruments monitor and automatically control every phase of the Socket Screw Division's metal treatment – including a variety of continuous and batch-type furnaces, salt-baths, and tinning and degreasing operations for specialty products.

Completely automatic control assures highest quality and uniformity for Bristol socket screw products. New instruments get grueling "field" tests before they're released for general distribution. And, last but not least, visitors to the Waterbury plant can see Bristol instruments under actual load conditions.

Drop in, when you're in the New England area, and watch these precision instruments at work!



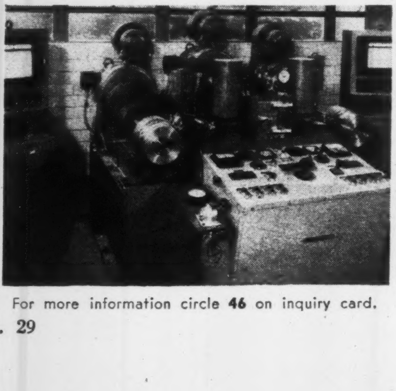
Telemetering helps control steel plant fuel

This Bristol telemetering installation helps U. S. Steel, Gary, Indiana, get the highest steel production with the lowest possible fuel cost.

The panel shows the amount of coke-oven and blast-furnace gas used throughout the plant as well as gas pressures at critical locations. With this complete supply and demand information at their fingertips, fuel dispatchers can control distribution for maximum efficiency and economy.

Precision rolling mill produces steel tapes 0.000125" thick

This precision cold-strip mill at The Arnold Engineering Company, Marengo, Illinois, rolls ultra-thin high-permeability strips for magnetic cores. The core strips may be as thin as 0.000125" and must be held to extremely close tolerances. To achieve the necessary precision, AccuRay gauges–employing Bristol Dynamaster recorders–measure thickness of material on both sides of the rolling mill. The AccuRay equipment is built by Industrial Nucleonics, Columbus, Ohio.



For more information circle **46** on inquiry card.

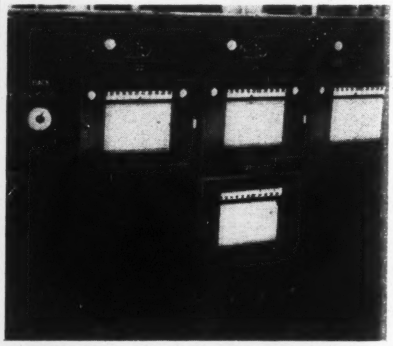
New control techniques cut fuel bills for metals

In 20 years, fuel required for ingot heating has dropped 50 to 60%.

A big share of the credit for this fuel economy goes to automatic control and instrumentation techniques developed recently. These new techniques, with better, faster, more accurate sensing and response, have chalked up significant savings, not only in fuel, but also in fixed charges, rolling time, and maintenance costs.

Probably most important for big savings is control of furnace temperature and atmosphere. Furnace pressure may be regulated by positioning the stack damper. Fuel-air ratio can be controlled by a valve in the air line. Air requirements for combined fuels may be totalized for better distribution of fuel throughout the plant.

Proper temperature-time sequences or "time cycles" also rack up big savings. Step heating sequences, differing for various metal ingots, no longer need be programmed by rule of thumb. Instead, any predetermined sequence of temperatures can be maintained automatically and easily changed to suit particular batches.



THESE BRISTOL ELECTRONIC AND AIR-OPERATED pyrometers automatically control regenerative soaking pits. Platinum, platinum-rhodium thermocouples at pit covers are sensing elements.

Want to apply these up-to-date control and instrumentation techniques to your industrial heating problem? Bristol engineers will be glad to talk over specific processes, problems, facts and figures with you. Write today to The Bristol Company, 113 Bristol Road, Waterbury, Conn.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING
AND TELEMETERING INSTRUMENTS

People IN THE NEWS

WEKSLER THERMOMETER CORP., Freeport, N. Y., announces election of *Harry Weksler* as chairman of the board, and *Edward P. Dobrin* as president.

NATIONAL BUREAU OF STANDARDS, Wash., D. C., announces awarding of the Dept. of Commerce silver medal for meritorious service to *Herbert C. Vacher*, head of the metallographic and X-ray diffraction laboratory.

NORTH ELECTRIC CO., Galion, Ohio, announces appointment of *William D. Wilson* as director of advertising.

NORDEN-KETAY CORP. announces election of *Perry R. Roehm* to succeed *Morris F. Ketay* as president.

MERCOID CORP., Chicago, Ill., announces appointments of *Willis E. Jones* as sales manager, *Paul J. Pro-ost* as manager of Industrial Controls Div., and *G. R. olds, Jr.* assigned to work at Industrial Controls Div.

BURGESS-MANNING CO. announces appointment of *llen Wilson* as vice president, and *Dudley W. Day* as a member of the Board of Directors.

DAYSTROM, INC. announces appointment of *Robert J. effries* as assistant to the president.

. J. COPE, INC., Collegeville, Pa., announces appointment of *Fred Ullberg, Jr.* as vice president in charge of sales.

MINIATURE PRECISION BEARINGS, INC., announces appointment of *Richard I. Kern* as general marketing manager, *Kenneth G. Broman* as sales manager and *Henry J. Egg* as western manager.

BALDWIN-LIMA-HAMILTON CORP. announces promotion of *Joseph Rosecky* to vice president in charge of the corporation's Eddystone (Pa.) plant. *Louis Fenn Sperry* has been elected to serve on the Board of Directors.

J. Rosecky
B-L-H

T. Gardner
Hycon

HYCON MFG. CO., Pasadena, Calif., announces election of *Trevor Gardner* as Chairman of the Board, and *Gilbert W. Kahn* and *Eaton Taylor* as Directors.

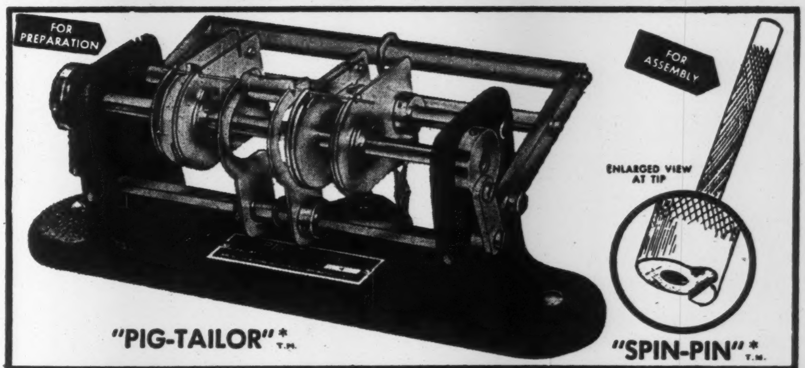
G. M. GIANNINI & Co. announces appointment of *J. Murray Wilson* and *Donald H. Putnam* as Directors.

UNION SWITCH & SIGNAL DIV. of Westinghouse Air Brake Co. announces appointment of *Harold J. Myers* as supervisor of product sales.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

● ● ● ● ●



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:
1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:
1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

*PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. IA-6P

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

For more information circle 47 on inquiry card.

COMPRESSED AIR AND GAS COME OUT OF THE LOGAN

ARIDIFIER

Scrubbed CLEAN AND DRY

INSTALL ARIDIFIERS ON LINES SERVING

- Paint Spray Guns
- Air Tools
- Air Hoists
- Foundry Jolting Machines
- Sand Blasting Tools
- Sand Blasting Rooms
- Metal Spray Guns . . . or Wherever the line must deliver clean, dry air or gas

On any air or gas line 92% of the dirt, oil, scale and water that enter the Aridifier is trapped and removed from circulation. The Aridifier's patented centrifugal-baffle action scrubs air and gas clean and dry . . . protects equipment, prevents freezing, fouling, corrosion and caking, produces best results with spray gun and air tool operations, etc. Easy to install. Self cleaning. Maintains itself. 10 models available. Capacity 7 CFM to 17,000 CFM.

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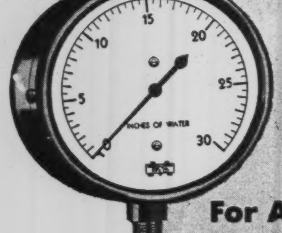
MARSHALLTOWN



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For Accurate Pressure Measurement in Ounces or Inches of Water

Available in standard dials (reading in inches of water) 0-15" —0-30" —0-60" —0-100" —0-160" ...also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MANUFACTURING CO.

MARSHALLTOWN 3, IOWA

For more information circle 49 on inquiry card.

PEOPLE—CONTINUED

WEST INSTRUMENT LTD., English plant of Chicago's West Instrument Corp., announces appointment of *James A. Hartnett* as managing director.

J. A. Hartnett
West Ltd.

O. P. Staderman
Bendix

P. C. Hutchinson
Perkin-Elmer

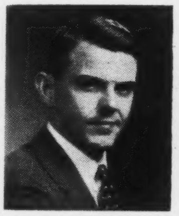
BENDIX COMPUTER DIV. of Bendix Aviation Corp. announces appointment of *O. Paul Staderman* as director of marketing.

PERKIN-ELMER CORP. announces appointment of *Paul C. Hutchinson* as director of sales of the Instrument Div., and *John D. Winninghoff* as director of sales of the Engineering and Optical Division.

GENERAL ELECTRIC CO. announces appointment of *Donald E. Carr* as manager of the new Industrial Electronics Laboratory.

SUPERIOR TUBE CO., Norristown, Pa., announces appointment of *William O. Nussear, Jr.*, as marketing manager.

CLIFTON PRECISION PRODUCTS CO., INC., Clifton Heights, Pa., announces election of *Arnold E. Hayes* as corporation secretary and general manger.


A. E. Hayes
Clifton

E. S. McCollister
Electrodata

D. J. Tricebock
Fischer & Porter

ELECTRODATA CORP. announces appointment of *Edwin S. McCollister* as vice president of marketing.

FISCHER & PORTER, Hatboro, Pa., announces appointment of *Donald J. Tricebock* as head of the new Instrument Div. Other appointments include: *Philip E. Sellers* as sales vice-president; *Herman Kockritz* as field sales manager and *Willaim Trethaway* as district manager of the Atlanta office.

MAGNETIC RESEARCH CORP., El Segundo, Calif., announces appointment of *A. R. Hunter* as national sales manager; *Amos Bernstein* as applications engineer; and *Sargent J. Ableman* as field sales and applications engr.

CENTRALAB, Milwaukee, Wis., announces appointment of *Frank Apple* as advertising manager.

PARKER APPLIANCE CO. has promoted *Edwin H. Crichley* to comptroller.

ROSS OPERATING VALVE CO., Detroit, Mich. announces election of *Henry M. Wood* to the Board of Directors.

For research . . . for quality control . . . for raw material inspection —

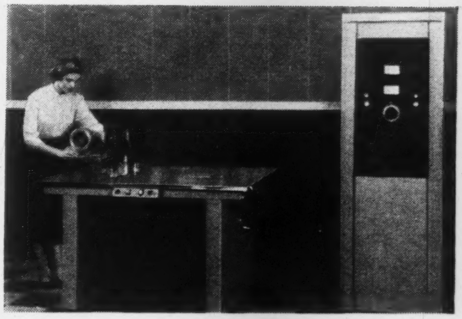
New G-E x-ray diffraction unit fits any analysis program

FOR fast, accurate qualitative or quantitative analysis of solids or liquids, the General Electric XRD-5 offers a host of new advantages.

New versatility! Basic components allow you to start with high-standard minimum equipment . . . add features as needs grow. Double duty! Twin-tube operation achieved simply by adding a second tube and ma control. New accessories! A full range of new accessories enables users to fully exploit the advantages offered by diffraction and emission technics.

The XRD-5 works equally well when analyzing large or minute samples. As for speed, one research laboratory cut its time on a product identification test from two days to five minutes—one half of one percent of the time formerly required by conventional chemical analysis.

For complete information on the XRD-5, consult your G-E x-ray representative. Or write X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin for Pub. BL-64.



General Electric diffraction unit equipped for minimum film technics. Added equipment (additional tube, shockproof case, and ma selector) provides facilities for up to six instruments at one time. Further additions will equip the unit for simultaneous film- and direct-measurement technics.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Manufacturers of the only compete x-ray line

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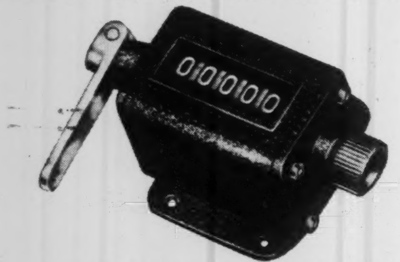
Why is COUNTROL

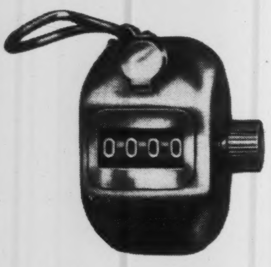
important in every business today?

Countless times a day, every business needs to know "how many? . . . how much? . . . how far? . . ." and many other questions that can be answered only by facts-in-figures. But how to get these figures . . . from so many different machines, processes, operations and systems? Veeder-Root Counters are doing it every day, by means of:



MECHANICAL COUNTING

Small Resets count strokes, turns, or pieces . . . are used by thousands for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.



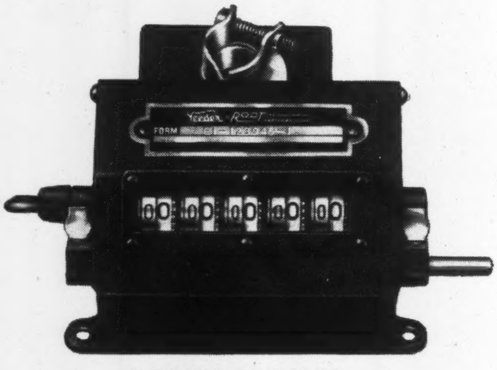
HAND COUNTING

Where objects or units cannot be counted electrically or mechanically, hand-operated counters like this Hand Tally do the job. For instance, quick spot checks of production or performance, traffic count, inventory, etc. Fits palm of hand, counts one for each pressure of thumb lever, resets to zero by turning knob.

156872
Veeder-Root Inc. Hartford, Conn.

ELECTRICAL COUNTING

These remote-indicating counters bring your production machines as close as your office wall. AC or DC, they can be connected in series with any simple switch, and will transmit production figures *instantly* over any distance. May be panel-mounted in groups.



CONTROLLING

Set it for the exact number of turns, pieces, or operations required . . . and this Predetermining Counter will control the run *exactly* . . . preventing over-runs and shortages. When the predetermined number is reached, counter will light a light, ring a bell, or actuate a stop-motion.

IN SUM: *If it can be counted or controlled . . . count on Veeder-Root to do it. Get in touch with your Industrial Supply Distributor for standard counters for application to your production machines and processes. And get in touch with Veeder-Root for counters to be built into original equipment.* **Veeder-Root Inc., Hartford 2, Connecticut.**

Insist on Standard

VEEDER-ROOT COUNTERS

from your Industrial Supply Distributor

®

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INSTRUMENTS
and
AUTOMATION

Biographies of significance

SIGNIFICANCE

"Mac" Fortney is too young to be called an "old timer"—but that he is in our young field of process instrumentation. In his 17 years as Foreman of the Instrument Department of the Baytown, Texas plant of Humble Oil & Refining Company (1937-1954), he guided the department through a five-fold expansion in personnel (from 37 to nearly 200) and a million-fold expansion in instrumentation problems as refining, ordnance and rubber plants were pyramided in the Humble system. His pride and affection for his instrument department, for which he planned carefully and fought continuously, is revealed dramatically in the pictures showing typical instrument activities at Humble—on pages 1134 and 1135 of this issue.

Mac has been a key figure in both Southern and national instrument activities. As a member of the original steering committee of the Texas A&M Symposium on Instrumentation for the Process Industries, the first president of the Houston Instrument Society, chairmen of several important ISA committees, and now first Vice President of the ISA, he is indeed an elder statesman whose contributions to our field well deserve our recognition.

Mac is not only well known in the field—he is regarded with high affection by his innumerable associates and friends. To know Mac is to like him. His delightful personality shows in the biographic details that he has set down here.

His comments, along with the picture story on pages 1134-1135, were cleared through channels at Humble up to the board level. Norman D'Olive, Associate Editor of the Humble BEE Magazine, attached a note to Mac's comments to the effect that they were too good to change. The board members evidently agreed with Norman and so do your editors—so here is a biographic sketch that is different.

Your editors know Mac intimately and were tempted to fill in the gaps in his biographic notes so as to emphasize his important contributions. But, as Norman D'Olive says, "Mac has such a delightful refreshing style that I didn't have the heart to change his own account of his colorful life." Neither do we—other than to reemphasize the importance to our field of such men who know its background, its history, its workers, and its practical operation.

W. H. (MAC) FORTNEY

An Autobiography

Born (nothing unusual about this), in Arkansas (. . . . .), but moved to Texas at an early date.

Was exposed to chemical and electrical engineering for about three years at the University of Texas. No degree, no honors, no outstanding records. There definitely are no statues to me on the campus at Austin.

Started in instrument work at the Texas Company in Port Arthur in July, 1923 (got off a tanker in port) and have been at it almost continuously. Exception: one year trying to sell specialties; some work on knock tests on motor gasoline.

With Humble 1927. Foreman Instrument Department, McCamey Refinery, 1929-30; pyrometer man during depression, Baytown Refinery. Department Foreman, Baytown Refinery, 1937 through 1954, except for one year as Assistant Superintendent M & C in Charge of Crafts (1951).

In 1937 the Refinery had only one process unit completely equipped with control instruments. The department totaled thirty-seven men, most of whom were specialized.

During the war the department, due to the growth of the Refinery and construction of Government-operated plants (ordnance, rubber plants, etc.), increased to about two hundred men. Anyone who considers the work involved in an expansion of this magnitude might easily understand the training problems involved. In those days there were no texts available and our material was assembled barely ahead of presentation.

First president, Houston Instrument Society (before affiliation with ISA). Chairman of Subcommittee RP-4 (control valves and manifolds), later Chairman of Recommended Practices Committee for two years. Have given papers before several local sections and at two National conferences. Author of about a dozen papers on various topics involving instrumentation. Hold one patent (worthless).

Vice-president ISA 1955-1956, First Vice-president 1956.

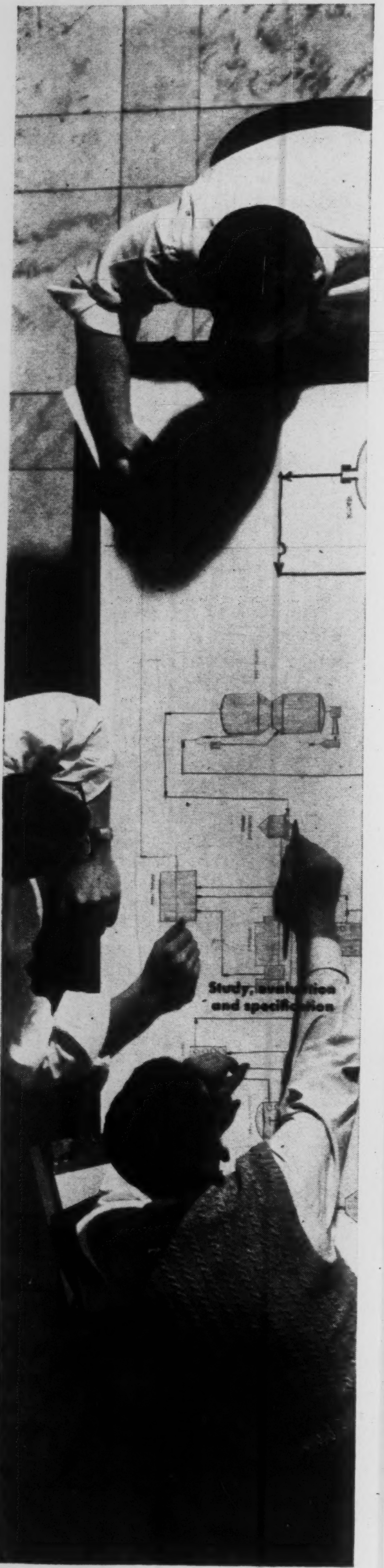
Member of original Steering Committee, Symposium on Instrumentation for Process Industries at Texas A & M College.

Houston Section representative, Houston Engineers Council, 1953-54, Chairman Convention Committee 1950. Past exalted ruler local elks Lodge. One-time president Baytown Water Board. *Also ran* for mayor. Have served as Director of Community Welfare League, Health League, Recreation Council, and I am now serving as Co-chairman United Fund Drive.

Married; two grown brats, one practicing law, one housewife. Wife has three grandchildren, but I call them "cousins." Hobbies—fishing (lying), "resting," which is fancy loafing, and am a champ at this.

As to how long I have been reading *I&A*—I thought I started in '27, but I don't believe it was published until '28. I am pretty sure that I was a reader before the '30's. In fact, I have received total issues enough to put me "ahead" of a charter subscriber (at one time I was receiving three copies: one on a personal subscription, one as an ISA member and one through a Company subscription).

There is no question as to *I&A*'s contribution to the growth of instrumentation, and particularly the contribution of Dick Rimbach to the technology and to the promotion and formation of the Instrument Society of America.



Automatic control systems engineered from conception to operation by a single, responsible service

The economy and efficiency of start-to-finish engineering of automatic control systems is available from Panellit's Instrument Services Division. This staff of mechanical, electrical and chemical engineers—all with process experience—offers the broad scope of instrumentation services outlined below. Where management's own instrument and process engineers or contracting organizations are available, Instrument Services Division supplements this personnel and provides specialized experience. Division activities have included major instrumentation projects in the process, power and atomic energy industries and for engine test facilities.

Studies and evaluations of instrument requirements are made, and recommendations are submitted. If desired, detailed specifications are prepared permitting the customer to invite bids on the recommended equipment.

Equipment installation, inspection and check-out are supervised by Division instrument engineers working with factory-trained craft foremen and technicians. Typical field work includes erecting panelboards, installing field-mounted transmitters, making electrical or tubing interconnections, as well as system testing, calibration, and start-up. (Installation services are offered for instrumentation only, not for its associated process equipment.)

Field maintenance of installed instrumentation is also provided by Instrument Services Division on a contract basis.

Overall project coordination of these individual services places entire responsibility for automatic control systems in one qualified organization. Since Panellit is concerned mainly with systems and manufactures no standard instruments available elsewhere, the Division has an impartial approach in recommending system components. Your inquiry is invited.

Equipment installation and check-out

Field maintenance

Overall project coordination

INSTRUMENT SERVICES DIVISION

Engineered Information Systems For Industry

Graphic Panels, Control Centers

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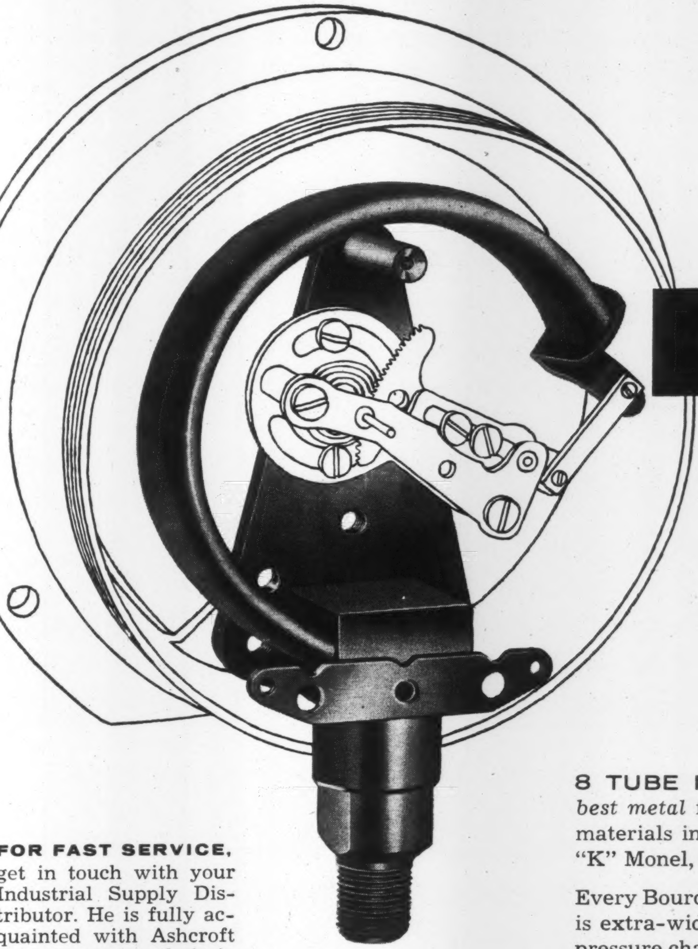


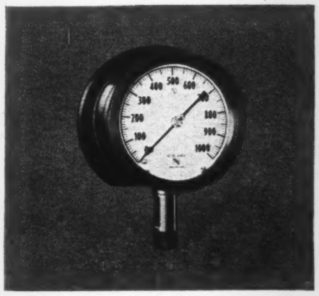
Why does the BOURDON TUBE in the ASHCROFT DURAGAUGE insure sustained accuracy?

FOR FAST SERVICE, get in touch with your Industrial Supply Distributor. He is fully acquainted with Ashcroft Duragauges and their proper selection for all kinds of applications.

8 TUBE MATERIALS permit selection of the *best metal* for particular service conditions. These materials include phosphor bronze, alloy steels, "K" Monel, stainless steels, and beryllium copper.

Every Bourdon tube used in the Ashcroft Duragauge is extra-wide – highly sensitive to slight pressure changes. Socket and tip joints are welded or brazed, then stress relieved after assembly, to assure maximum safety and uniform structure for highest corrosion resistance and strength. Each tube assembly is "whip tested" at pulsating pressures approximately 50% higher than its pressure rating to insure calibration stability.

The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A choice of case designs and materials, dial sizes and pressure ranges readily satisfy the most exacting requirements. Whatever the working pressures or corrosive conditions of your operations, specify Ashcroft Duragauges and be sure of highest sustained accuracy and long service life.



1850 ASHCROFT U.S.A

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

MAXWELL MANNING & MOORE INC. M&M TRADE MARK

For more information circle **53** on inquiry card.

Quiz program on L&N's new Speedomax "H"

Research Director: *"Where can I use this new Speedomax 'H' in my lab?"*

L&N Field Engineer: *"They're being used for all kinds of millivolt measurements, recording temperatures of pilot plants and experimental setups, and controlling lab furnaces. One firm is even using them for temperature checks of fire-proof vaults."*

Research Director: *"What conditions can they measure besides temperature?"*

L&N Field Engineer: *"There are three pH ranges, three millivolt ranges and we even have instruments for measuring nuclear activity such as Log N, Log Count Rate, etc. And we're making fast delivery on all standard ranges."*

Research Director:*"What do you mean by fast delivery?"*

L&N Field Engineer: *"Within two to four weeks after we receive your order, depending on model."*

Instrument Engineer: *"That's pretty good . . . now, just how accurate are these H's?"*

L&N Field Engineer: *"Plus or minus one-half percent of the range span. The full scale balancing time is 5 seconds."*

Instrument Engineer: *"That's plenty for many of our jobs. What else can you tell us about the instrument?"*

L&N Field Engineer: *"Well, all potentiometers are automatically standardized. And you can get any control element you want. On-off control, 2-or-3 action electric and 3-action electro-pneumatic control are available."*

Research Scientist: *"Many of our jobs are short ones. Do we have to buy a new instrument or make expensive changes between jobs?"*

L&N Field Engineer: *"Definitely not! It's very easy to change ranges. All you do is pick up a screwdriver and put in a new range card, scale and chart paper. The control elements simply plug in, and so do the amplifier and other components."*

Instrument Engineer: *"They seem like excellent instruments; can you tell me something about their price?"*

L&N Field Engineer: *"Depends on the instrument, of course, but they're from a fifth to a third less than our larger Speedomax 'G's,' and only take up half as much space in your lab. Here are some Data Sheets that will give you specs and other information to help in planning your possible applications."*

If you would like a set of Data Sheets on the Speedomax "H" and any other information on these inexpensive recording and controlling instruments, request Data Sheets ND46-33(100-106) from any L&N Sales Office or from Leeds & Northrup Company, 4955 Stenton Ave., Philadelphia 44, Pa.

LEEDS NORTHRUP
instruments *automatic controls • furnaces*

Speedomax H

For more information circle **54** on inquiry card.

INSTRUMENTS and AUTOMATION **Editorial**

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—***M. H. Aronson,*** Editor

MECHANICAL MEASURING INSTRUMENTS INDUSTRY

Advance Report; 1954 Census of Manufactures*

DURING 1954, manufacturers in the Mechanical Measuring Instruments Industry shipped products valued at $792 million, an increase of 87 percent over 1947, according to preliminary results obtained from the 1954 Census of Manufactures conducted by the Bureau of the Census, Department of Commerce. Average employment in this industry has increased 13 percent since 1947 (when the last Census of Manufactures was taken) to a total of 68.5 thousand employees in 1954. Value added by manufacture in the industry amounted to $534 million in 1954, an increase of 90 percent over 1947. "Value added" is derived by subtracting the cost of materials, etc. from the value of shipments. It avoids, therefore, the duplication in the value of shipments which results from the use of products of some establishments as materials by others and is the best measure available for comparing the relative economic importance of manufacturing among industries and geographic areas. Changes between the two Census years for other key measures of activity for the industry are shown in Table 1. No adjustments have been made for changes in price levels between the two years. All figures in this report are preliminary and, therefore, subject to revision in the final industry bulletin.

Definition of Industry

The Mechanical Measuring Instruments Industry represents manufacturing establishments engaged primarily in the manufacturing of mechanical instruments for indicating, recording, measuring, and controlling temperature, pressure, mechanical motion, rotation, flow, liquid level, humidity, density, acidity, alkalinity, and combustion; dial pressure gauges; physical-property testing apparatus such as hardness, tension, compression, torsion, ductility, and elasticity testing apparatus; and instruments for household and office use such as thermometers, barometers, and rain gauges. Establishments primarily manufacturing instruments for indicating, measuring, and recording electrical quantities and characteristics are classified in Industry 3613, Electrical Measuring Instruments; watches and clocks in Industry 3871, Watches and Clocks; and measuring and dispensing pumps in Industry 3586, Measuring and Dispensing Pumps. The industry classification for mechanical measuring instruments used in the 1954 Census of Manufactures is based

Table 1.—General Statistics for the Mech. Meas. Instruments Industry, USA.

(Standard Industrial Classification Code 3821)

Item	Unit of measure	1954	1947	Percent change 1947-1954
Establishments	Number	609	466	+31
All employees:				
Number	Thousands	68.5	60.5	+13
Payroll	Million dollars	298.1	173.9	+71
Production workers:				
Number	Thousands	47.7	46.7	+2
Man-hours	Millions	96.6	93.1	+4
Wages	Million dollars	187.7	122.4	+53
Value added by manufacture[1]	do	534.2	281.5	+90
Cost of materials, fuel, electricity, and contract work[2]	do	256.4	141.9	+81
Value of shipments[3]	do	792.2	423.4	+87
Capital expenditures, new	do	21.4	8.8	+143

Value of shipments less cost of materials, supplies, fuel, electric energy, and contract work.

Excludes cost of products bought and resold in the same condition.

Includes, for all establishments classified in this industry, not only (a) their value of products "primary" to the industry, but also (b) their value of "secondary" products, which are primary to other industries, and (c) their "miscellaneous receipts" for repair work, sale of scrap, installation of own products, etc. Excludes sales of products bought and resold in the same condition.

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* Series MC-38-1.4, April, 1956, U.S. Department of Commerce; available from Bureau of Census, Washington 25, D. C., and U.S. Dept. of Commerce Field Offices.

EDITORIAL—CONTINUED

on the *Standard Industrial Classification Manual,* Volume I, Manufacturing Industries, 1945 edition.

The value of shipments, as reported by establishments classified in the Mechanical Measuring Instruments Industry, consisted not only of products described above as primary to the industry, but also included the value of secondary products (which are primary to other industries). In Tables 1 and 3, the $792 million total value of shipments reported by establishments classified in Industry 3821, Mechanical Measuring Instruments, consisted of $764 million manufactured products and $28 million miscellaneous receipts for contract work, repair work, sales of scrap, etc. The $764 million product shipments were accounted for by $667 million of mechanical measuring instruments and $97 million of products primary to other industries (e.g. ordnance, valves and fittings, scientific instruments). Thus, the industry's shipments of mechanical measuring instruments represented 87 percent of its total manufactured product shipments (primary and secondary). This figure describes the "primary product specialization ratio," that is, the extent to which plants classified in an industry "specialize" in making products regarded as primary to the industry. The 1947 primary product specialization ratio for the industry was 83.

The industry's total value of shipments should be clearly distinguished from the total value of primary products of the industry shipped by all producers. The latter figure, appearing in Table 2, indicates that $845 million value of mechanical measuring instruments and other products primary to Industry 3821 were shipped by all producers. Of this total, 79 percent was shipped by plants classified in Industry 3821, while the remainder was shipped as secondary products by plants classified in other industries. The figure 79 percent is known as the "coverage ratio," that is, it measures the extent to which all shipments of primary products of an industry are "covered" by plants classified in that industry, as distinguished from secondary producers elsewhere.

Table 2.—Quantity and Value of Mechanical Measuring Instruments Shipped by All Producers in the U.S.

(Includes products reported both by establishments classified in the Mechanical Measuring Instruments Industry and items as "secondary" products in other industries)

Product code	Product	Total shipments including interplant transfers			
		1954		1947	
		Quantity [1,000 units]	Value ($1,000)	Quantity (1,000 units)	Value ($1,000
3821	Mechanical measuring instruments, total	xxx	[1]845,342	xxx	425,277
3821111	Aircraft engine instruments	xxx	80,257	xxx	4,992
38212	Integrating meters, nonelectrical type	xxx	106,174	xxx	63,262
3821211	Gas meters	1,609	37,840	1,335	22,459
3821231	Water meters	1,352	37,298	1,338	23,246
3821298	Other liquid meters (except electric), including gasoline dispensing[2]	xxx	31,036	xxx	17,557
38213	Industrial process instruments, including indicating, recording and controlling instruments (excluding aircraft, nautical, navigational, electrical quantity measuring and automotive types)	xxx	271,518	xxx	168,369
	Temperature thermometers (glass stem and bi-metal):				
3821311	Industrial and laboratory	xxx	11,347	xxx	12,549
3821313	Clinical	10,789	6,320	9,296	5,360
3821315	Household	13,642	6,808	13,494	4,051
3821321	Temperature instruments, others than thermometers	xxx	55,268	xxx	44,120
3821331	Pressure and vacuum	xxx	44,901	xxx	27,535
3821341	Fluid flow and liquid level	xxx	39,927	xxx	19,211
3821351	Physical properties testing and inspection equipment, including hardness, strength of materials, wear, abrasion, and similar testers	xxx	19,472	xxx	13,402
3821398	Other industrial process instruments	xxx	87,475	xxx	42,141
38214	Motor-vehicle instruments	xxx	76,401	xxx	39,495
3821411	Speedometer for motor-vehicles[3]	8,585	28,774	(NA)	11,433
3821498	Other motor vehicle indicating instruments, except electric (fuel level, oil pressure, etc.)	xxx	47,627	xxx	28,062
3821511	Automatic temperature controls, activated by pressure, temperature, level, flow, time, or humidity (including pneumatic controls) of the type principally used as components of air-conditioning, refrigeration, and comfort heating or as components of major household appliances	xxx	259,970	xxx	100,640
3821611	Other and not specified mechanical measuring instruments	xxx	51,022	xxx	48,519

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[1] Of this total, 79 percent was shipped by plants classified in the Mechanical Measuring Instruments Industry; the remainder was shipped as secondary products by plants classified in other industries.

[2] Includes some gas and water meters shipped unassembled from the factory.

[3] Excludes some speedometers produced by plants of motor vehicle companies for incorporation into automobiles and trucks of their own assembly.

[NA] Not available.

The general statistics (employment, payrolls, cost of materials, value of shipments, etc.) are reported for each establishment as a whole. Aggregates of such data for an industry reflect not only the primary activities of the establishments in that industry, but also their activities in the manufacture of secondary products and receipts for their other activities (contract work on materials owned by others, repair work, etc.). This fact should be taken into account in comparing industry statistics (Tables 1 and 3) with product statistics (Table 2) which show the shipments by all producers of the primary products of the industry.

More detailed figures for this industry will appear later in the Census Bulletin, MC-38A, "Instruments; Surgical, Dental, and Ophthalmic Goods," which will be published and offered for sale at a later date by the Superintendent of Documents, U. S. Government Printing Office.

The 1954 Census of Manufactures is the twenty-sixth such census of the United States since 1809.

Table 3.—General Statistics for the Mechanical Measuring Instruments Industry by Region.

Region and State	1954										1947	
		All Employees		Production Workers								
	Establishments, number	Number	Payroll ($1,000)	Number	Man-hours (1,000)	Wages ($1,000)	Value added by manufacture[2] ($1,000)	Cost of materials etc.[3] ($1,000)	Value of shipments[4] ($1,000)	Capital expenditures, new ($1,000)	All employees, number	Value added by manufacture[2] ($1,000)
United States, total[5]	609	68,458	298,144	47,679	96,633	187,676	534,240	256,384	792,198	21,424	60,481	281,482
New England	74	9,723	41,614	6,698	13,745	25,290	77,419	32,547	111,539	3,347	8,481	42,172
Middle Atlantic	213	22,114	96,965	15,575	30,431	62,260	165,043	80,693	245,737	4,587	21,362	99,328
East North Central	153	19,653	85,530	13,490	28,365	53,241	150,305	85,729	236,034	5,017	17,323	
West North Central	26	7,867	33,675	5,349	10,974	19,688	68,977	21,294	90,271	2,565		
South	63	2,900	11,610	2,278	4,489	8,358	20,514	9,995	30,509	1,151	2,198	10,636
Mountain	8	61	214	43	82	128	263	381	645	38		
Pacific	72	6,135	28,533	4,242	8,543	18,708	51,717	25,742	77,460	4,714		

[2] Value of shipments less cost of materials, supplies, fuel, electric energy, and contract work.

[3] Includes cost of materials, fuel, electricity, and contract work; excludes cost of products bought and resold in the same condition.

[4] Includes, for all establishments classified in this industry, not only (a) their value of products "primary" to the industry, but also (b) their value of "secondary" products, which are primary to other industries, and (c) their "miscellaneous receipts" for repair work, sales of scrap, installation of own products, etc. Excludes sales of products bought and resold in the same condition.

[5] Sum of regional figures may not equal U. S. total, due to independent rounding.

Dear D.R.*:

If all your screens are installed and vacation plans made, you will have some time to relax and enjoy several of the important things in this issue. We will brief you on them here so you won't miss any of them.

Last month you learned about the 3 basic techniques used for analog-to-digital conversion. This month you will see (in Number 9 of the series on Digital Automation) how these basic techniques are put to work for specific tasks. The wide variety of types of available digital converters may give you lots of ideas.

All you power-house men will be interested in the new Number 8 power station of the Hawaiian Electric Company, shown on the front cover and described on pages 1118-1120. Of particular interest are the reasons why pneumatic control was chosen, the philosophy behind the design of the control room, and the combustion control system design factors.

You "plumbers" will be particularly interested in the articles "Evaluation of Valve Mechanical Characteristics" by J. T. Ward of du Pont and Otto Kneisel of Hammel-Dahl, and "Pneumatic Actuators" by Chet Beard (Number 6 in his series). Here again, the wide variety of available pneumatic actuators for valves will help you choose the best for that particular job.

As we haven't had very much on the subject of high-resistance measurement lately, and as such measurements are becoming more important in etched circuitry, potted circuitry, etc., we selected the article "Slideback Electrometer" for you this month. It tells how the Diamond Ordnance Fuze Laboratories measure resistances up to 10^{15} ohms.

We think the review article on "Analytical Instruments" by Herb Simon of The Fluor Corporation (on pages 1141-1145) is also of high educational value. It tells where and why specific analytical instruments should be used, and packs a lot of practical analytical chemistry in its discussion on principles.

Many of you know Mac Fortney (of the Baytown, Texas plant of Humble Oil) well—but all of you will enjoy his "autobiography" on page 1097, and the Instrument Department of his plant (shown on pages 1134-1135) should make a lot of you instrument men sit up and take notice.

Hope this finds you well and happy. See you next month.

Cordially,
Milt and the Editors

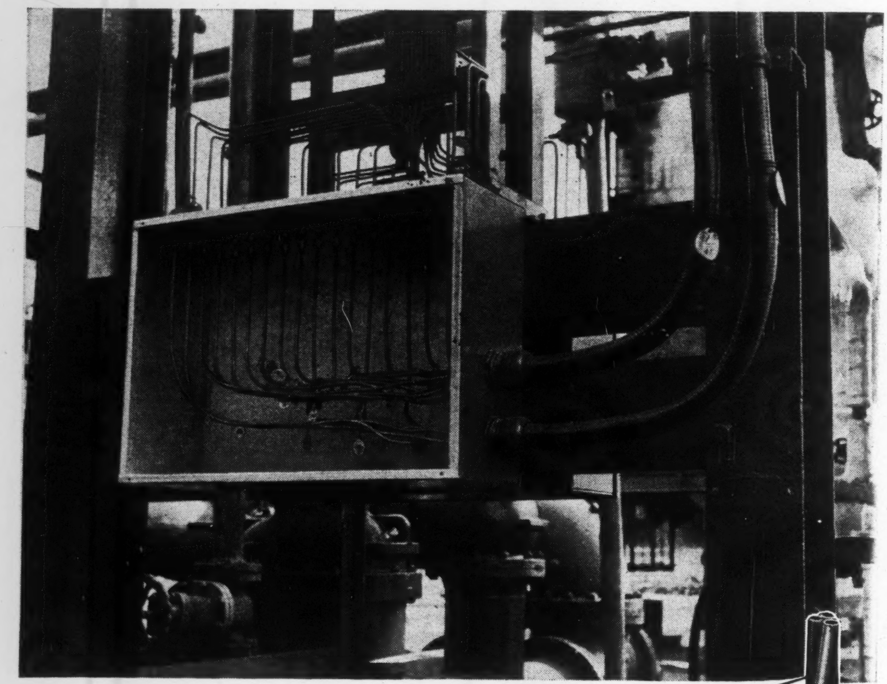
Dear Reader

CRESCENT ARMORED MULTITUBE

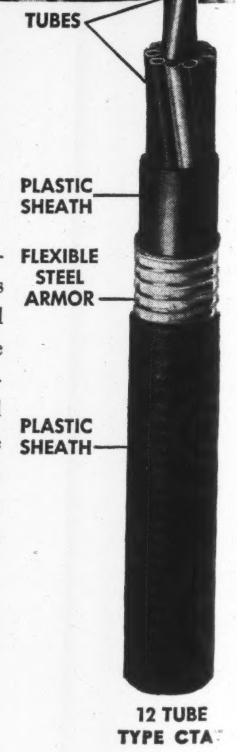
On The Industrial Unit At The Bayway Refinery of ESSO STANDARD OIL COMPANY

....proved easy and economical to install....

The illustration shows CRESCENT ARMORED MULTITUBE as it enters the junction box from the right, connecting with individual tubes for relaying to the elaborate instrumentation system.



12 Tube CRESCENT ARMORED MULTITUBE with thermoplastic sheath over flexible steel armor, feeding into CRESCENT Plastic Coated, Single Tube.



....*and it is the Solution to Your Corrosion Problems*

CRESCENT ARMORED MULTITUBE is a complete system of tubing for effective pneumatic and hydraulic instrument controls. It consists of long length tubes TWISTED TOGETHER to permit bending without distortion. In each layer one tube is a bright blue color, affording a fast means of identification of each tube at both ends. It is available with 2 to 37 copper tubes, ¼″ O.D. in continuous lengths up to 1000 feet. Also furnished in aluminum, steel or polyethylene tubes, and in ⅜″ and ½″ O.D. sizes.

The type illustrated here provides maximum protection against corrosion, as well as mechanical injury to the tubing during and after installation. Substantial savings can be made on *installed* cost as compared with conventional single tubing. CRESCENT Armored Multitube gives a *better protected* and more *permanent installation.* Special construction is also available for permanent, direct-burial underground. This product is licensed under U. S. Patent 2,578,280.

Send for bulletin giving complete information and engineering data.

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For more information circle **55** on inquiry card.

Thomas A. Edison Inc.'s

PERSONAL DEMONSTRATION

shows how you can

INCREASE PLANT PRODUCTION

Our representatives throughout the nation are ready to demonstrate *a complete* Omniguard system right at your plant or office.

Takes Only a Few Minutes to Prove Simple Omniguard System Protects Bearings and Processes; Cuts Down Time; Increases Equipment Life

Just take a few minutes to prove to yourself how Omniguard can make it possible for you to operate your equipment at peak production rates without fear of breakdowns . . . how this simple temperature detection system gives you ample opportunity to prevent bearing failures or to keep process temperatures within limits.

RECORDS REVEAL FAILURES COSTLY

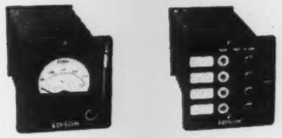
Many operators—after a record check—are astonished to find how much bearing breakdowns have been costing them in maintenance and lost production. They see that the cost is often many times the expense of installing Omniguard.

COMPLETE 4-POINT SYSTEM FOR LESS THAN $500

Consider the thousands of dollars involved in equipment and production output. Contrast this with the fact that one Omniguard unit costs less than $500. And because of its simplicity, installation costs are also low.

SIMPLE, DEPENDABLE

Omniguard has no electronic or moving parts. It is the most dependable system available today. Modular in design, each unit gives you four-point detection. You can add as many as you need . . . as you need them.



The modular indicator and monitor, with their mounting brackets, and the resistance temperature detectors, are all you need for a continuous operating analysis of remote process or bearing temperatures.

Resistance Temperature Detectors

These are just four of the many different types of temperature detectors produced for varied applications of the Omniguard system.

The 242P for high temperatures (to 1300°F.)

The 166NC with pre-loaded sensitive tip specially designed for bearing protection.

The 230N for general purpose industrial use (stem-sensitive).

The 235N90-35 for fast response in corrosive service.

A Partial List of Present Users

American Blower Corp.
City of Chicago
Combustion Engineering, Inc.
DeLaval Steam Turbine Co.
Eastman Kodak Co.
Esso Standard Oil Co.
Florida Power & Light Co.
General Electric Co.
Hercules Chemical Co., Inc.
I-T-E Circuit Breaker Co.
North American Aviation, Inc.
Public Service Electric & Gas Co.
Republic Steel Corporation
Sun Oil Company
Union Carbide & Carbon Corp.
Westinghouse Corp.

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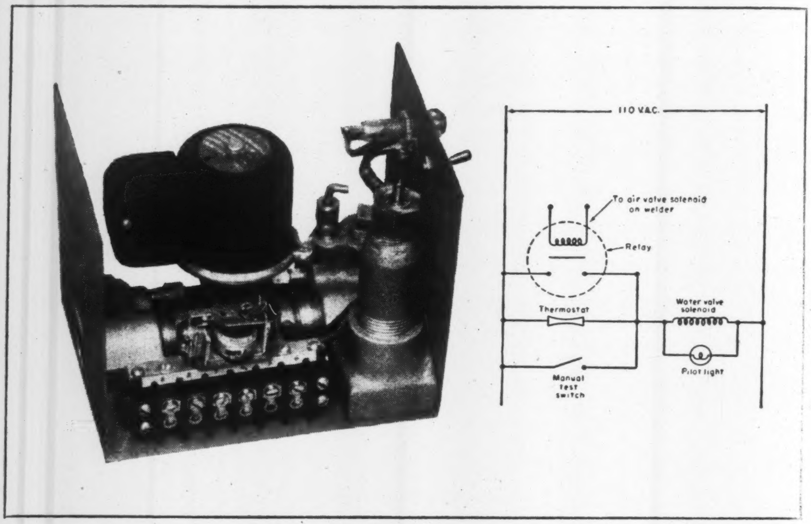
How to Control Cooling Water

No. 5 of a series — *Showing the Broad Application Range of Fenwal Controls*



FENWAL THERMOSWITCH unit provides control of cooling water in the Water Mizer, a coolant control for welding and brazing made by Van Vooren Products, East Moline, Illinois. Compact Fenwal units are easily adjustable, highly resistant to shock and vibration and are totally enclosed against dust and dirt.

The Water Mizer is used for resistance welders, induction-heating equipment and hydraulic systems. The unit turns on the cooling water at the initiation of a cycle by means of a relay tied into the operating cycle.

The problem was to stop the water flow to the electrode after the machine is idle for a time long enough to cool the electrodes. Here's how a Fenwal THERMOSWITCH unit solved it —

When the welder is started, the Water Mizer, through a relay control system connected to the air solenoid valve coil or clutch on the welder, releases a full flow of water. The relay control keeps the water valve open until the cooling water becomes warmer than the Fenwal THERMOSWITCH setting, at which time the THERMOSWITCH takes over and controls the flow according to operating requirements.

How Fenwal Thermoswitch Units Operate

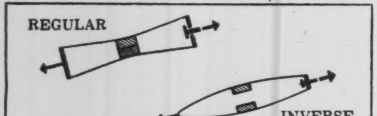
In THERMOSWITCH thermostats the activating *control* element is the metal shell which encases the contact elements. Changes in temperature cause the shell to expand or contract instantaneously. This exerts either tension or compression on the struts, causing the contacts to make or break a circuit. Control in the Fenwal THERMOSWITCH units is calibrated at a given shell temperature by turning the adjusting screw until contacts operate.

Fenwal THERMOSWITCH controls are constructed as either tension or compression operated with regular or inverse contact arrangements.

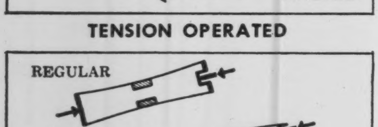
Tension operated units may be subjected to momentary temperature exposure of 100°F above their set point. They also may be subjected to any temperature below their set point without danger. Tension operated Fenwal THERMOSWITCH units may be set below 0°F but compression operated units are recommended if rapid temperature changes in excess of 100°F or extreme temperature overshoots are to be encountered.

Fenwal compression operated units may be exposed to a temperature of −100°F indefinitely, and to temperatures 400°F above their set temperatures for short periods of time.

The Fenwal THERMOSWITCH Control is constructed with two silver contacts mounted on, but electrically insulated from, curved nickel-iron struts of low expansion coefficient. This element assembly is then mounted under tension or compression in a seamless drawn brass or stainless steel tube. The amount of tension or compression is variable, depending on the position of the adjusting sleeve and the temperature of the shell.



TENSION OPERATED



COMPRESSION OPERATED

Proved Applications

Fenwal Sales Representatives and Engineers have saved time, trouble and money in all types of plants and laboratories by solving thousands of temperature control and detection problems. Fenwal THERMOSWITCH units are controlling processes that involve liquids, gases and solids.

Put Fenwal's vast reservoir of technical know-how to work for you. Chances are your problem has already been met and mastered by Fenwal engineers.

Write for new Catalog No. 500 for details and complete product listings on Fenwal THERMOSWITCH Thermal Controls, including units discussed above, Midget and Miniature versions of these, Snap-Action Controls, and Indicating Controllers.

FENWAL INCORPORATED
366 Pleasant Street
Ashland, Mass.

Please send me your Catalog No. 500. Our specific problem is: . . . .

Name . . . . *Title* . . . .
Address . . . .
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Fenwal CONTROLS TEMPERATURE . . . *PRECISELY*

For more information circle **57** on inquiry card.

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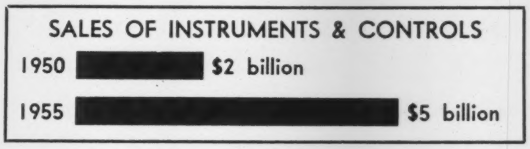

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In the "Guide" pages of this annual directory, we list *your* products FREE . . . as a service to the buyers of nstruments and automatic controls who use the directory through 12 months of product selection.

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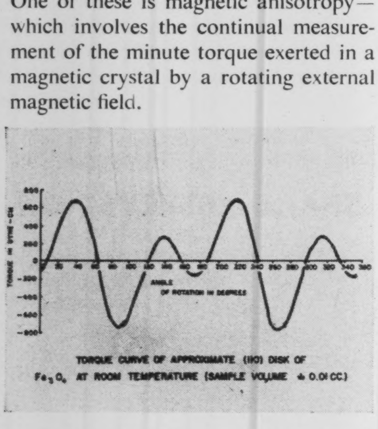
- **Incubator Hatched: Tube elements spaced 1/5000 of an inch apart; assembled in the Very Clean Room.**

For bulletins, write to Dept. SA6, IBM, 590 Madison Ave., N.Y. 22, N.Y.

Merry-go-round

Adding "memory" to machines is no longer a scientist's fancy. It is a fact. Actually, this ability to "remember" is the ability to "recall" information previously entered into the machine. One of the latest and best ways of storing information utilizes the now familiar small, rugged, reliable magnetic cores. Each letter or numeral is stored in a kind of a "Morse code," where a dash is represented by one direction of magnetization and a dot by the other. But, to employ cores more effectively, the IBM Research people are studying a number of very basic things having to do with ferrites. One of these is magnetic anisotropy—which involves the continual measurement of the minute torque exerted in a magnetic crystal by a rotating external magnetic field.



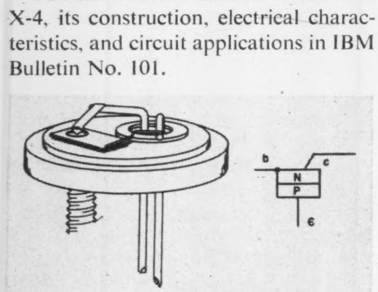
TORQUE CURVE OF APPROXIMATE (110) DISK OF Fe_3O_4 AT ROOM TEMPERATURE (SAMPLE VOLUME ≈ 0.01 CC)

To increase the speed and accuracy of measurement of this property, Ralph Penoyer, of our Ferrite Materials Research Group, has developed an automatic magnetic torque balance that is accurate to 0.0006 inch-ounce, and allows the direction of the magnetic field to change through a 360° arc in one minute. Obtaining and plotting such data was, by standard methods, a laborious, time-consuming process. Full details describing the device, circuit diagrams, method of operation, calibration and accuracy are available in IBM Bulletin No. 100. Write for your copy.

Trigger Happy Transistor

Everybody is talking about transistors. But, certain problems are not readily solvable by the use of conventional transistors. A typical problem is that of picking up a relay with a transistor controlled by microsecond pulses. So Richard Rutz, of our Semi-Conductor Devices Research Group, took a long look at transistor possibilities in this case. The result: The IBM X-4 Transistor. This new type permits high-speed switching of large currents by low-power electrical pulses. It operates with a turn-on time of two ten-millionths of a second and a turn-off time of one-millionth of a second; experimental models have been made to switch currents as high as 15 amperes.

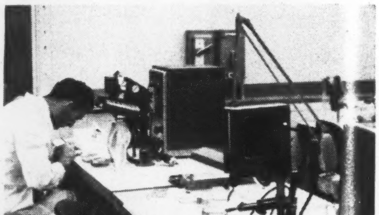
You can find full scientific data on the X-4, its construction, electrical characteristics, and circuit applications in IBM Bulletin No. 101.



IBM X-4 THYRATRON TRANSISTOR

Incubator Hatched

Dirt, dust and moisture are death to delicate electrical devices. In our experimental component assembly room—which we call the Very Clean Room—at our Poughkeepsie Research Laboratory, we've eliminated the scourges. How do we keep the Very Clean Room clean?



Clean, temperature- and humidity-controlled air is blown into the room, keeping the pressure inside greater than outside. Therefore, when one enters from the outside no dirt enters with him. As a further precaution, he must wear a lintless nylon lab coat over his clothing. Dry, clean, compressed nitrogen replaces compressed air to blow off particles of dirt that may accumulate on an assembly. Since a great deal of work in this room is done under microscopes, with wire as small as one-sixth the diameter of the average human hair, controlled atmospheric conditions are vital.

To learn more about career opportunities available at IBM, write, describing your background, to: W. M. Hoyt, IBM, Room 3606, 590 Madison Avenue, New York 22, N. Y.

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DATA PROCESSING · ELECTRIC TYPEWRITERS · TIME EQUIPMENT · MILITARY PRODUCTS

IBM® INTERNATIONAL BUSINESS MACHINES CORPORATION

Digital Automation—No. 9

Practical Analog-Digital Converters

The following converters, most of which are commercially available, show the state of the art and the types of converters designed for (1) shaft position conversion with binary output, (2) shaft position conversion with uncoded output, (3) shaft position conversion for direct data printing, (4) data loggers with all-electronic conversion, and (5) all-electronic high-speed conversion.

MARTIN L. KLEIN
FRANK K. WILLIAMS
HARRY C. MORGAN
Rocketdyne Div.,
North American Aviation, Inc.

THE three basic techniques for analog-to-digital conversion were described in the previous chapter as (1) space encoding, (2) voltage comparison or feedback, and (3) sweep time or time base. The space-encoding converters (with the exception of the cathode-ray type) are electromechanical in nature, using codes laid out on discs, plates, drums, wheels, etc., and with brushes or photocell-type pickups. The voltage-comparison and sweep-time types are usually all-electronic in nature.

Converters can be classified also in terms of output. Most encoders produce a coded output (binary, Gray, etc.). However, converters which translate a shaft position or an analog voltage into a decimal-type readout are also analog-to-digital converters. Indeed, several converters are available with either uncoded pulse, binary or binary-coded decimal readout. The following commercial equipments illustrate the many variations of converters now available. There is no clear distinction between types because converters with pulse-type outputs can be easily adapted to yield a binary-coded output via a series of flip flops, binary codes can be converted to decimals via a matrix, etc.

Converters can be classified also in terms of function and mechanism. As shown in the following listing of available converters, one group uses coded discs and drums for relatively rapid (several hundred shaft revolutions per minute) conversion of shaft position—with either brushes or phototubes being used as the pickup elements. Several other converters translate shaft position into uncoded pulse form, by use of magnetic or inductive technique. Other converters are designed especially for data printing or readout, some of which are designed for use with relatively slow-speed (1 per second) recorders and are electromechanical in nature; others use all-electronic circuitry for faster conversion as in high-speed data loggers and data-reduction systems. The last group listed comprises the high-speed all-electronic analog-to-digital converters—the peak of the conversion art today, performing digital conversions at rates of tens of thousands of conversions per second.

SPACE ENCODERS with CODED DISCS and BRUSHES
- Coleman
- Electro-Mec
- Kearfott
- Librascope
- Norden-Ketay
- Wang Laboratories

SPACE ENCODERS with CODED DISCS and PHOTOTUBES
- Electronics Corporation of America
- Encoder Div., Baldwin Piano
- W. & L. E. Gurley
- Wang Laboratories

SPACE ENCODERS with INDUCTIVE or MAGNETIC ELEMENTS
- Farrand Controls
- Jacobs Instrument
- Telecomputing

SPACE ENCODER with D'ARSONVAL MOVEMENT
- Assembly Products

SPACE ENCODER for TANK GAGING
- Vapor Recovery Systems

SHAFT QUANTIZERS for DIGITAL PRINTOUT or READOUT
- Coleman
- Consolidated Electrodynamics (SADIC)
- Datex Div., G. H. Giannini (coded disc)
- Fischer & Porter (coded drum)
- Genisco (coded disc)
- Remington Rand (segmented commutators)
- Streeter-Amet (cam type)
- Taller & Cooper (cam type)

ALL-ELECTRONIC DATA LOGGERS
- Consolidated Electrodynamics (sweep time)
- Kybernetes (sweep time)
- Metrotype (voltage comparison)
- Non-Linear Systems (voltage comparison)

ALL-ELECTRONIC HIGH-SPEED CONVERTERS
- Epsco (voltage comparison)
- Radiation, Inc. (voltage comparison)
- J. B. Rea (voltage comparison)
- Rocketdyne (voltage comparison; also sweep time)

Coleman Engineering Company

Fig. 9-1 (top) shows the binary "Digitizer"* of Coleman Engineering Company, Inc.; at bottom is shown a decimal "Digitizer."

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*Registered trademark Coleman Engineering Company

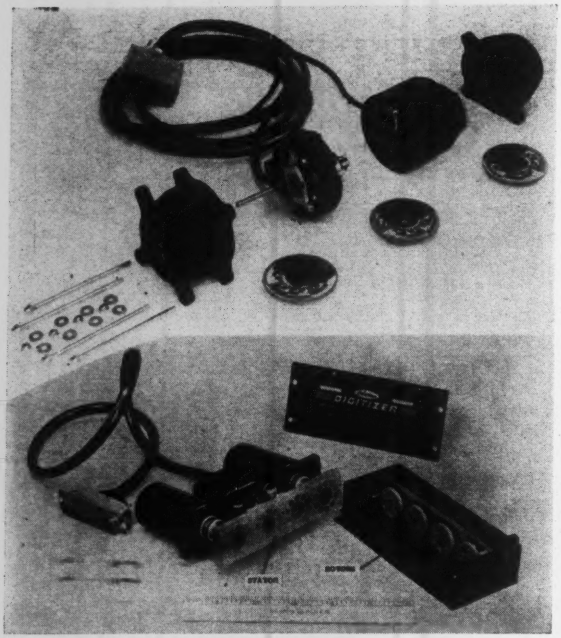

DIGITIZER
STATOR
ROTOR

Fig. 9-1. "Digitizer" of the Coleman Engineering Company. Binary "Digitizer" is shown at top; decimal "Digitizer" at bottom.

Each binary disc has six coded zones and thus gives 2^6 or 64 counts per shaft revolution. The common technique for obtaining more counts is to gear discs together via a gear ratio. For example, gearing two coded discs through a gear ratio of 16:1 (2^4) provides a total count of 1024 ($2^6 \times 2^4$ equals 2^{10} or 1024). Note that 16 revolutions of the input shaft are then required for the total count of 1024.

The binary unit provides 64 counts per shaft revolution, and is available with 10-bit (1023 count) and 15-bit (32,767 count) codes. Maximum slewing speed is over 12,000 rpm; output is straight parallel binary. Ambiguity in progressing from one reading to the next is eliminated by use of dual brushes; relays (controlled by the appropriate bit on each of the contact rotors) select the proper reading brush. Readings may be made while shaft is in motion only if both brushes are read out and brush selection is made by electronic means.

A binary-coded decimal unit (1-2-4-8 code) is available with 60 counts per shaft rotation; max. count of 1999; and max. slewing speed above 12,000 rpm.

The decimal unit is used to operate a typewriter, etc. This has 10, 40 or 100 counts/shaft rotation; is available in 3, 4, 5 or 6 decade models; max. slewing speed is 18,000 rpm.

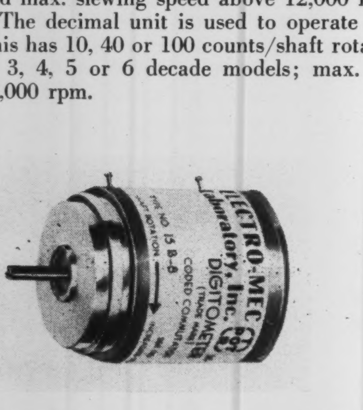

ELECTRO-MEC
Laboratory, Inc.
DIGITOMETER

Fig. 9-2. The Electro-Mec "Digitometer" uses brushes on coded disc.

Electro-Mec Laboratory, Inc.

The Electro-Mec "Digitometer" (Fig. 9-2) uses brushes on coded disc. Models are available with 8-bit (256 count) or 10-bit (1024 count) outputs in reflected binary (Gray) code.

Maximum rotational speed is 650 rpm; service life is 5 million revolutions.

Kearfott

Fig. 9-3 shows the "ADAC" (analog-digital-analog) converters offered by Kearfott Company, Inc. Direct-driven and servo-driven converters are available.

The converters use metallic drums coded via conductive and nonconductive segments. The direct drive unit shown weighs less than 4 ounces; the servo unit (not shown) weighs 13 ounces. Both use cyclic codes (wherein only one bit changes between any two successive numbers) to minimize ambiguity.

Readout, which can be made while the drum is rotating or on demand, is performed by sending an interrogating pulse to all the drums. If a brush is on a conducting segment the pulse can return to the output or digital computer; if on a nonconducting segment, no pulse is returned. The basic ADAC has 12 takeoff tracks (3 takeoffs and 1 input per drum), and thus a capacity of 2^{12} or 4096 counts; 256 revolutions are required for the total count. The accuracy of one part in 4096 is 0.02%, or approx. 5 minutes of shaft rotation. Maximum shaft speed is 1000 rpm.

Variations of ADAC include units with outputs in binary-coded decimal and pure binary coding.

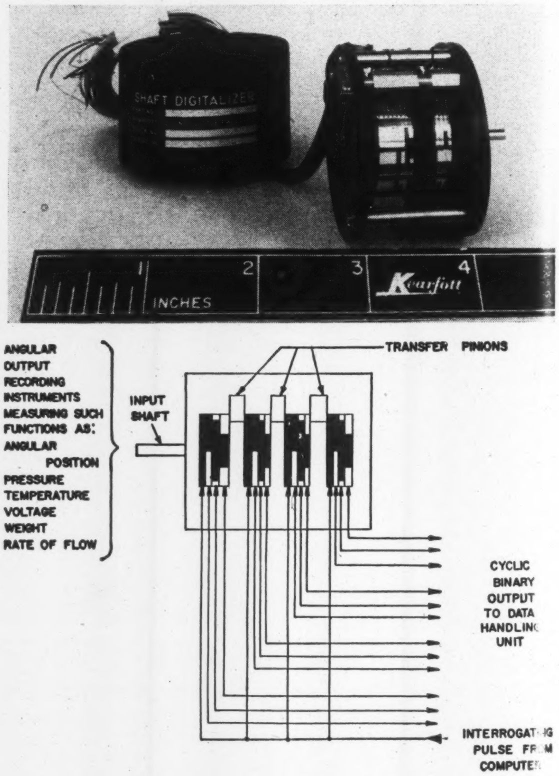
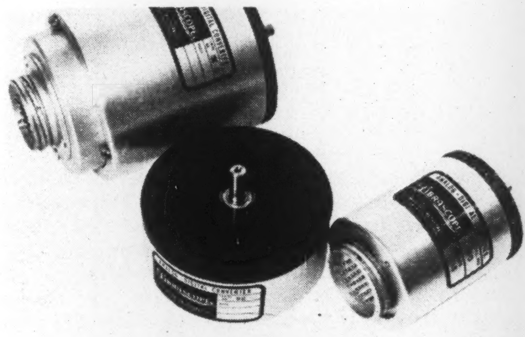
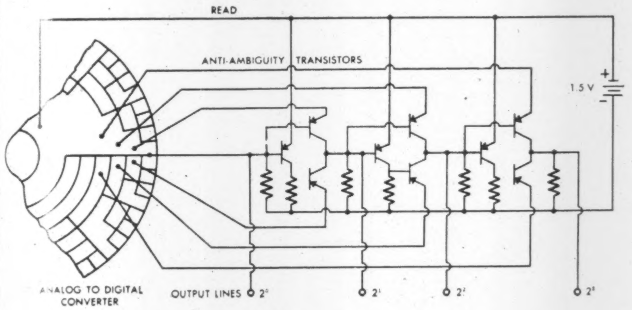

SHAFT DIGITALIZER
1
2
3
4
INCHES
Kearfott
ANGULAR OUTPUT RECORDING INSTRUMENTS MEASURING SUCH FUNCTIONS AS: ANGULAR POSITION PRESSURE TEMPERATURE VOLTAGE WEIGHT RATE OF FLOW
INPUT SHAFT
TRANSFER PINIONS
CYCLIC BINARY OUTPUT TO DATA HANDLING UNIT
INTERROGATING PULSE FROM COMPUTER

Fig. 9-3. (Top), direct-drive ADAC of Kearfott with binary decimal code. (Bottom), 4-drum ADAC with cyclic binary code. Twelve readout channels (3 on each drum) provide 2^{12}, or 4096, counts—in 256 revolutions of input shaft.

Librascope, Inc.

Fig. 9-4 shows the principle used in the Librascope converter, with associated circuitry for a 4-bit parallel-coded output. Brushes make contact with conductive portions of the disc. The discs can also provide serial output. Discs are available for 19-bit or more binary-coded output. Note the use of transistor circuitry to eliminate ambiguity. Typical specifications include shaft speed of 2 revolutions per second; slewing speed of 1500 rpm for short intervals.




READ
ANTI-AMBIGUITY TRANSISTORS
1.5 V
ANALOG TO DIGITAL CONVERTER
OUTPUT LINES 2^0
2^1
2^2
2^3

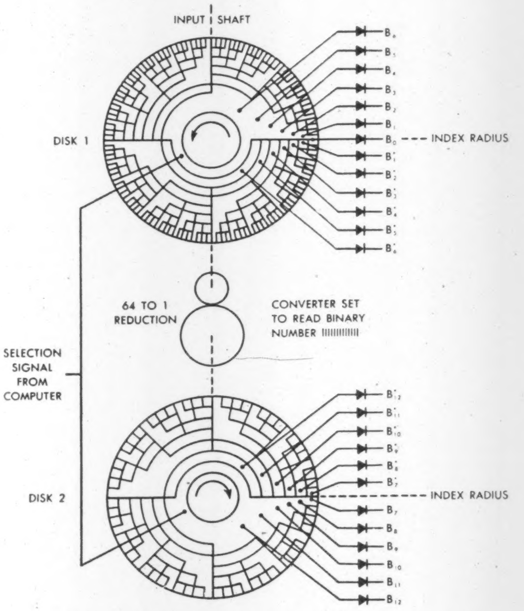

INPUT SHAFT
DISK 1
B_6
B_5
B_4
B_3
B_2
B_1
B_0
INDEX RADIUS
B'_1
B'_2
B'_3
B'_4
B'_5
B'_6
64 TO 1 REDUCTION
CONVERTER SET TO READ BINARY NUMBER IIIIIIIIIIII
SELECTION SIGNAL FROM COMPUTER
DISK 2
B'_{12}
B'_{11}
B'_{10}
B'_9
B'_8
B'_7
INDEX RADIUS
B_7
B_8
B_9
B_{10}
B_{11}
B_{12}

Fig. 9-4. The Librascope converter also uses brushes on a coded disc. Transistor circuitry is shown for ambiguity elimination with a four-bit output. Discs are geared to obtain a 12-bit output.

Features include a staggered double-brush pick-off system. Ambiguity is eliminated by two brush pick-offs reading each track except the least significant. Brushes can be read serially or in parallel using a scan matrix of relays or transistors, and the circuit is readily time-shared. For multi-channel systems the unit employs isolation diodes in series with each pick-off brush, allowing one set of circuits to be used for scanning many converters.

Several models are available with 128 counts per revolution; others with 200 counts per revolution. Maximum recommended sampling rate is 1 Mc. For 13 bits, therefore, the sampling rate (time for complete conversion) would be 13 microseconds. Minimum sampling rate in cps is given by (rpm) (counts/rev)/30. Ambiguity can be eliminated by using this formula.

As with most stated specifications, the converters can be operated at higher than recommended rotational speed at the sacrifice of operating life. Typical life expectancy is 3 million revolutions. Converters can be operated at any speed so long as they do not require more than a 1-Mc sampling rate (1 microsecond per bit).

Norden-Ketay

Fig. 9-5 shows the ADC-1A-13A digital converter of the Norden-Ketay Corporation, which uses brushes on a coded disc. The output, which can be read while the shaft is in motion, represents a 13-bit binary number presented in parallel form in natural binary notation. The output is 2^{13} or 8,192 counts; hence accuracy is 1 part in 8,192 or 0.012%. Other converters of this type are available with output of 2^2 to 2^{19} counts.

Four brushes per digit are used to obtain the unambiguous binary output without external transformation circuits. Outputs V_1, V_2, etc. have ZEROs when their complements (V_1', V_2', etc.) have ONEs (arbitrary values of voltage), as shown in Fig. 9-5, B.

The output changes from 000 to 001 by moving the brush assembly one segment width to the right. Moving the assembly another segment width will produce the binary 010. The procedure may be continued until the

ANALOG-DIGITAL CONVERTER
NORDEN-KETAY CORPORATION

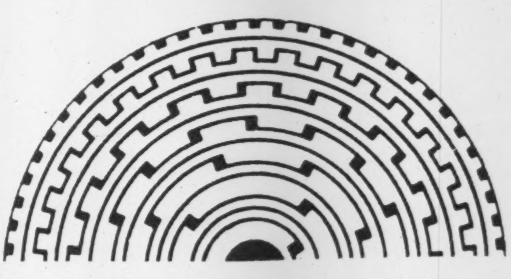


Fig. 9-5,A. Norden-Ketay encoder uses brushes on 7-bit coded discs. One disc gives 128 counts per revolution. At operating speed of 200 rpm, total count is 425 per second. Total count of 2^{13} is obtained by gearing two discs through a 64:1 gear ratio ($2^7 \times 2^6 = 2^{13}$).

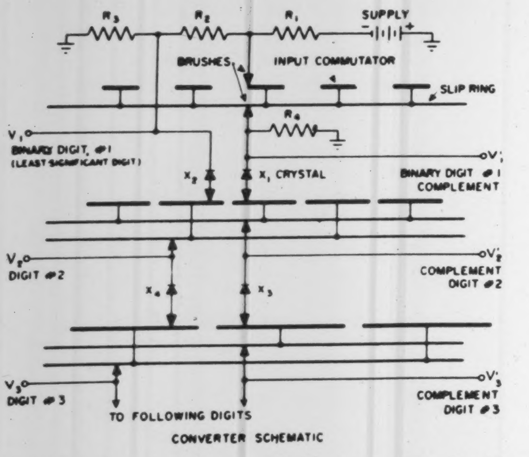


Fig. 9-5,B. Four brushes per digit are used in the Norden-Ketay converter to give binary output and complements.

13-digit binary number has all ones at output V_1 through V_{13}; 64 input revolutions are required for the complete count of 2^{13} because it is difficult on a small-size disc to code more than seven bits of information, or 128 counts. To obtain another 2^6 counts it is necessary to use another disc with a gear ratio of 2^6 (64 to 1) between the first disc (high speed) and second disc (low speed). This gives a total count of $2^7 \times 2^6$ or 2^{13} counts as the capacity of both discs when used together.

There are 128 counts per revolution and the recommended operating speed is approximately 200 rpm (a figure that will increase). This gives a total of about 425 counts per second when operated at the recommended speed. Sampling for information, however, can be at almost any rate because the output of the converter is represented in parallel form.

Note that complements of the output number are available simultaneously with the number.

Wang Laboratories, Inc.

Wang Laboratories offers angular-position encoding units based on either brush contacts on a coded disc or light transmissions through a coded disc. Fig. 9-6 shows the former, which is called a non-ambiguous coded type because all discs are coded in a non-ambiguous (cyclic) code so that no ambiguities can arise at any transition point because only one binary digit changes at a time in the transition from one unique postion to the adjacent unique position. Multi-turn models have more than one disc; these are geared. A special contact arrangement eliminates any possible error due to backlash of the gears. Several models of this type are available. One type resolves a complete revolution of the shaft (360°) into 1000 parts. A second type is a modification which resolves 320° to 336° into 1000 parts.

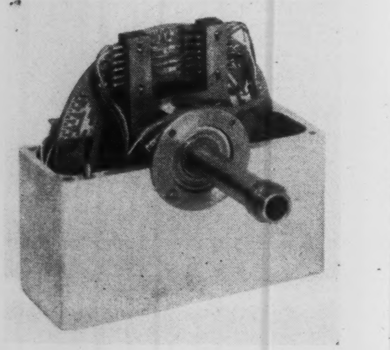


Fig. 9-6. Angular position encoders of Wang Laboratories are available either with brushes (as shown) or with photoelectric technique.

To accommodate "on the fly" as well as stationary shaft read-out, the information of the disc is transferred to a storage. This is done by pulsing the common line of the disc. The pulse will pass through only those contacts touching a conducting segment and will set the appropriate cells of storage. The data are held in storage and translated until read-out is completed, after which the storage is cleared. The standard storage and translation equipments consist of thyratrons and relays (rack mounted).

The photoelectric coder is called the "incrementa coded type" because the register follows the position o the shaft at all times by utilizing the incremental change of the shaft position as picked up by photocells. The register starts with an initial reading which can be set to an value corresponding to the initial position of the shaft. A the shaft moves from the initial position by a certain uni angle, the register will register one incremental change

Maximum resolution of both types is basically 1/100 revolution—that is, 360-degree shaft rotation is divide into 1000 parts. A 10-bit count is used to give the resolution of 1/1000. Maximum shaft speed is 1800 rpm; 60 rpm during readout.

SPACE ENCODERS WITH CODED DISCS AND PHOTOTUBES

Electronics Corporation of America

Fig. 9-7 shows the shaft-position encoder of the Electronics Corporation of America. A cyclical-binary code, expressed as clear and opaque areas in concentric rings, is printed photographically on a glass disc. The use of a

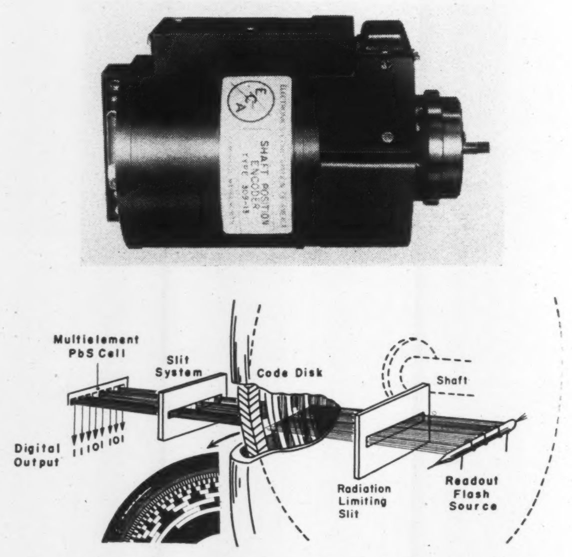


Fig. 9-7. Shaft position encoder of the Electronics Corporation of America uses clear and opaque areas on disc and photoelectric technique to develop code. A 13-digi system is available with one 4-inch-diam unit.

cyclic (Gray) code on the disc limits ambiguity to the least-significant digit because only one digit changes in progressing from a number to the next, as explained previously. A gas-discharge lamp placed to cover all channels is flashed periodically. The radiation transmitted through the disc causes voltage pulses (representing binary ONEs) to be generated by those elements of a multi-element PbS cell on which the light falls. Cell elements shielded by the opaque areas of the code disc give no signal (binary ZERO). The output can be serialized and converted to binomial-binary code. Sine-cosine codes may also be encoded on the ring.

A 13-digit direct-reading system (4 inches in diam and weighing less than 4 lbs) divides one shaft rotation into 8,192 discrete positions; a 16-digit system (10 inches in diam) divides one rotation into 65,536 discrete positions.

Maximum rate of readout is 600 times per second. This is the highest rate at which the light source can be flashed with sufficient intensity to assure an adequate signal from the detector.

Owing to the short flash duration (6 usec), accurate readouts can be obtained at angular velocities up to 1200 rpm. At this rate not more than 1 count unit (i.e., the width of one discrete element on the outermost channel of the code disc) passes in front of the detector while the reading is being taken.

Encoder Div., The Baldwin Company

An optical analog-to-digital encoder has been developed by the Baldwin Piano Company which provides binary parallel code signals representing any angular position to an accuracy better than 10 seconds of arc. Shaft angles are sampled at rates up to 100 cycles per second; 50,000 quanta per second may be scanned with the Baldwin converter (corresponding to a speed of 45 revolutions per minute). The heart of the system is an 8½″-diameter glass disc on which the code pattern is placed photographically by a special machine developed by Baldwin to divide one rotation of the shaft into 65,536 (2^{16}) discrete steps whose boundaries are accurate to 8 parts per million in relation to one another. A unique feature provided in the photo-transistor readout is an extra photocell which scans a clear zone on the disc to provide a light intensity reference for automatic compensation in event of changes in flash lamp intensity.

Code wheels containing sine-cosine functions or converters containing these wheels will be available. Any type of nonlinear code including any trigonometric functions, logarithmic functions, or hyperbolic functions can be produced on the special Divided Circle Machine developed by the Baldwin Piano Company.

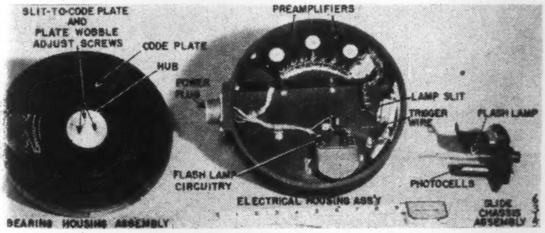


Fig. 9-8. Photoelectric analog-to-digital converter offered by The Encoder Div., The Baldwin Piano Co., provides 16-bit output.

W. & L. E. Gurley

The W. & L. E. Gurley company, specialists in precision engraving and photo-engraving techniques, has pioneered in precision binary coded discs. They offer 13-zone and 16-zone Gray binary coded discs. Linear patterns are also offered both in Gray binary code and in conventional straight binary coding. (These linear patterns are made to a precision of better than 5 microns over the total pattern length.)

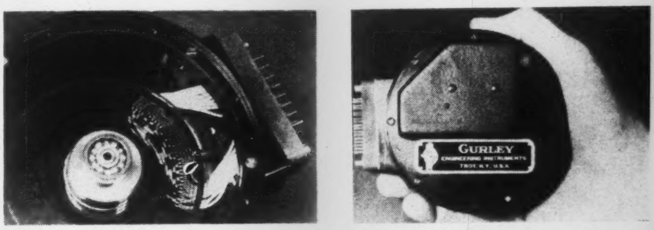


Fig. 9-9. Photoelectric converters of W. & L. E. Gurley feature 13- and 16-zone Gray binary coded discs.

The encoders use photoelectric technique, with either a pulsed or a continuous light source transmitted through the coded disc. A 13-zone converter with a 5″ disc is available with either pulsed or continuous light source. A compact 13-zone converter with a pulsed light source is available having a diameter of only 3½″ and a length of 2″; its weight is only 19 ozs (Fig. 9-9). These 13-zone units can read 8192 positions per revolution with an accuracy of ± 15 seconds of arc. A 16-zone unit will shortly be available utilizing a pulsed light source and capable of reading 65,536 positions per revolution with an accuracy of ± 5 seconds of arc.

Wang Laboratories, Inc.

As mentioned previously (see Fig. 9-6), Wang Laboratories offers an angular position encoder based on light transmission through a coded disc. It is called an "incremental" unit because it registers incremental changes as its shaft rotates. The output is 1000 counts per revolution.

SPACE ENCODERS WITH INDUCTIVE OR MAGNETIC ELEMENTS

Farrand Controls, Inc.

The Farrand analog-digital converters employ the "Inductosyn" as the data pickoff element (Fig. 9-10) on the input shaft. The Inductosyn is an inductive device, and is essentially a multipole resolver with errors of less than ten seconds of arc.

In one type of converter, a 128-pole Inductosyn receives a set of voltages derived from a binary counter and analog computer. The phase of the error voltage from the Inductosyn operates a gate that permits the counter to add or subtract, thus maintaining the error at ± one count in a high-speed electronic servo. Conversion accuracies of one part in 131,072 (17 bits) over one revolution of the input shaft have been obtained. This system is inherently capable of digital-to-analog conversion to the same accuracies.

A simpler system, now in development, incorporates pulse converters mounted on shafts controlled by an

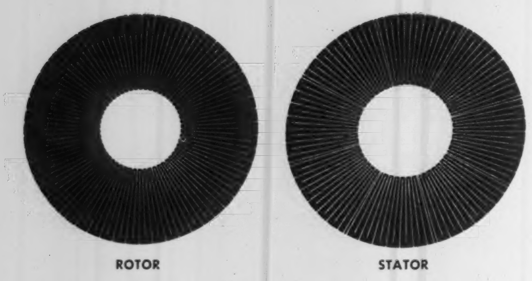


Fig. 9-10. "Inductosyn" element of Farrand Controls is essentially a multipole resolver.

Inductosyn-resolver Electronic Gear Ratio Servo. The pulse converter consists of pairs of inductive data elements for each binary digit. Each succeeding inductive pair has twice as many poles as the preceding pair. These devices are connected by thyratron pulse circuits in such a way that the binary number representing the shaft position is obtained when the circuit is given a "read" pulse.

As the number of binary digits per revolution affects the servo requirements imposed on the Electronic Gear Ratio, maximum shaft velocity is a function of the number of bits. A 16-bit converter (with accuracies of one part in 65,536) over one revolution, may be operated at input shaft speeds up to 10 rpm. This device will occupy one cubic foot of space, less power supply, and will function successfully at remote stations up to 50 feet from the Inductosyn mounted on the input shaft. Serial readout is available, on demand, at rates up to several thousand per second.

The first converter described generates binary information essentially continuously, and can be read at any time. The second (pulsed) type can be commanded to read at a rate up to 1000 times per second. The counting speed of 50,000 per second permits a resolution of 2^{18} per revolution at shaft speeds of 60° per second. No ambiguity error is possible; readout is on-demand parallel type.

The Jacobs Instrument Company

The Jacobs Instrument Company offers several shaft-rotation digitalizers, custom built to application. The principle used is the recording of magnetic pulses on a disc (Fig. 9-11) at a density of 250 to 300 pulses per inch. Another type uses optical recording with 2000 pulses per inch. If the 250 to 300 pulses per inch are placed on a 3″-diam disc, the resolution is about ⅛°.

The pulses are picked off the disc (either by a magnetic head or a photoelectric technique) and pass through a gate to a counter. A flip-flop circuit can be used to translate these pulses into binary code; a ring counter if decimal readout is desired. The maximum number of readings that can be made per minute depends on the speed of rotation of the disc and the frequency response of the magnetic pickoff head.

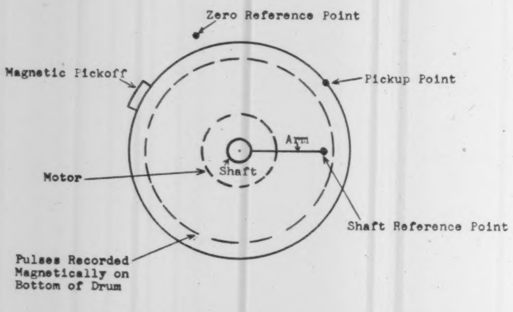


Fig. 9-11. The Jacobs Instrument Company uses magnetic pulses on a disc and a magnetic pickup head to develop the output signal. Another type offered uses optical recording of pulses on a disc.

Telecomputing Corporation

Fig. 9-12 shows the shaft position encoder of Telecomputing Corporation, which is based on a magnetic principle. The principle of operation is shown in A and B. The rotor of the digitizing element is energized with high-frequency (1.6 Mc) current. It is wound so that the currents in adjacent segments are 180° out of phase, as shown in B. The pickup functions like a coil that is passed under the pattern shown in B—that is, it has induced in it a signal that fluctuates from a maximum in one polarity to zero to a maximum in the other polarity as it moves past any two adjacent line segments of the rotor. Fluctuations in the output signal thus can be counted to represent the displacement of the rotor with respect to the pickup. Two pickups (shown as two patterns on the pickup in A) are spaced ¼ segment apart for direction sensing.

The rotor moves with the shaft. The signal from the stator is fed to amplifiers and counters. The permissible shaft speed is 1800 rpm; present resolution is 1000 or 2000 counts per revolution (depending on model).

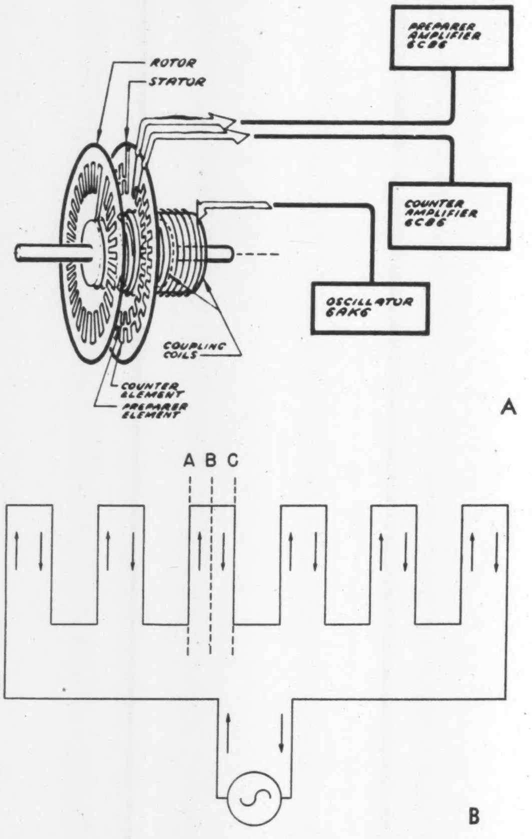


Fig. 9-12. Converter of Telecomputing Corporation (A) uses magnetic principle. (B) shows winding pattern so that signal changes polarity as rotor moves past any two adjacent line segments.

ENCODER WITH D'ARSONVAL MOVEMENT

Assembly Products, Inc.

Fig. 9-13 shows the "Low-Current Analog-to-Digital Converter" or "LiAD" of Assembly Products, Inc. This is simply a D'Arsonval movement with a coded dial plate replacing the normal face plate. When energized, a pusher bar presses the pointer against the dial plate; making contacts on the coded plate to give the digitized output directly. The readout coil (which pulls the pusher bar and the pointer against the coded plate) can be energized manually or automatically. Fastest operation is about 2 times per second. Resolution is 2%.

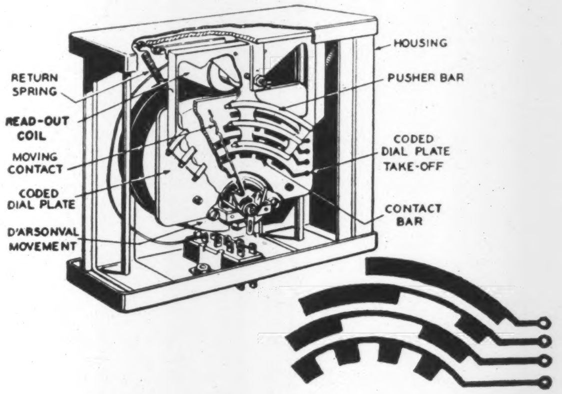


Fig. 9-13. "Low-Current Analog-to-Digital Converter," of "LiAD" of Assembly Products presses D'Arsonval movement pointer against coded plate to develop code.

ENCODER FOR TANK GAGING

The Vapor Recovery Systems Co.

Fig. 9-14 shows the coded discs used in the tank-gaging transmitter of The Vapor Recovery Systems Company. A 14-bit code is needed for readout of level up to 60 feet in ⅛-inch increments. Disc at left is "inch" disc; disc at right is "foot" disc. Each disc has 7 radial tracks, giving the required 14 elements for the complete liquid-level code. Brushes make contact with conducting portions of the discs.

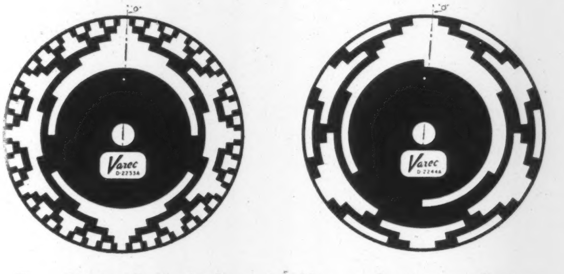


Fig. 9-14. Coded discs in Vapor Recovery Systems tank-gaging instrument permit direct readout of 60-foot heights to nearest ⅛ inch.

SHAFT QUANTIZERS FOR DATA PRINTING

Coleman Engineering Company

The Coleman Engineering Company, Inc., offers the decimal "Digitizer" (shown in Fig. 9-1) for automatic operation of typewriters, data loggers, etc. This unit has 10, 40 or 100 counts/shaft rotation and is available in 3, 4, 5 or 6 decade models.

Consolidated Electrodynamics (SADIC)

Consolidated Electrodynamics Corporation offers the "SADIC" converter, which is a self-balancing Thomson-Varley potentiometer having discrete digital balancing positions. Speed of conversion is about 1 per second, with accuracy of 1 part in 1000. Features include digital light display and decimal coded contacts for operation of typewriters, card punches, etc.

CEC "MilliSADIC" all-electronic data loggers for more rapid data-logging and data-reduction applications are described in a following discussion of "all-electronic data loggers."

Genisco, Inc.

The Genisco Shaft-to-Digital Converter (Fig. 9-15) provides decimal output, which can be converted readily into binary code via simple diode networks. The output is 10 counts per revolution of input shaft.

Readout is decimal, on command. As readout must occur while rotor is stationary, readout rate depends on how rapidly driving source can come to rest. Operating speed is 1800 rpm max in standard configuration; and life is 400 x 10^6 number changes without servicing. Power required is 90 v d-c at 80 ma per decade. Each decade is 1⅝" square x 2¼" long. Weight is approx. 2 lbs for a 3-decade stack, as shown.

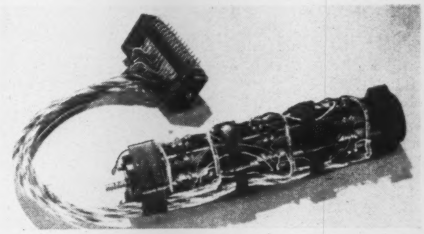


Fig. 9-15. Genisco converter provides decimal output.

G. M. Giannini & Co., Inc.

The DATEX Division of Giannini offers a line of shaft position encoders (Fig. 9-16) based on coded discs and brushes. The encoders are made with a variety of coded discs—standard binary (binomial), Gray, binary decimal, and a special Giannini DATEX code which is a variation of the cyclic code. The latter is used to minimize ambiguity error, as has been explained previously.

The encoders are designed to work with existing instrumentation (self-balancing potentiometers, card and tape punches, mechanical printers, typewriters, etc.) so as to produce information in digital form. Components are available for use with the Brown "Electronik," L&N "Speedomax," Bristol "Dynamaster," and other potentiometers, with Clary Printer or IBM Summary Punch, and/or visual light banks as the readout device.

In the Giannini DATEX code, an arabic decimal number is first translated into a cyclic decimal number and binary coded. (A cyclic decimal number is one which is decimal in nature but which changes only one character at a time; for example, in adding one unit to the decimal number 099, the result is 199, not 100.) The commutators are coded in a binary-coded cyclic-decimal code. The

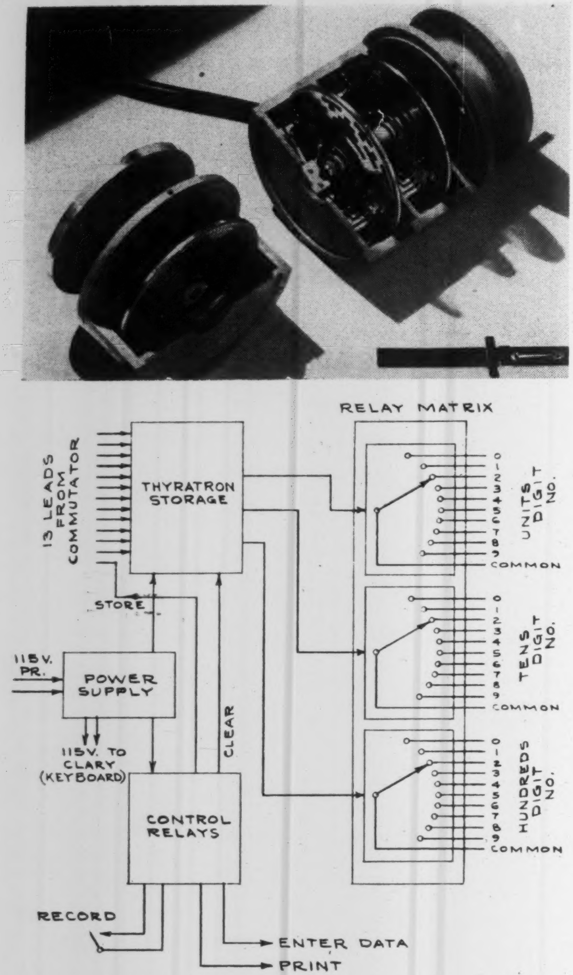

RELAY MATRIX
13 LEADS FROM COMMUTATOR
THYRATRON STORAGE
STORE
115V. PR.
POWER SUPPLY
115V. TO CLARY (KEYBOARD)
CLEAR
CONTROL RELAYS
RECORD
ENTER DATA
PRINT
0 1 2 3 4 5 6 7 8 9 COMMON
UNITS DIGIT NO.
TENS DIGIT NO.
HUNDREDS DIGIT NO.

Fig. 9-16. Top, Giannini DATEX encoders. Control chassis (bottom) contains thyratron storage and relay matrix for translating code from converter into printed decimal data.

binary-coded information coming from the encoder is in cyclic-decimal form and is transposed into conventional arabic decimal form in a recording matrix, as shown. The commutator has 12 segmented rows and 12 brushes; a 13th brush provides a common return. This code has 1000 unique combinations per revolution; hence the resolution is 1 part in 1000. The code is converted into decimal form by a control chassis, containing storage register, relay matrix, control relays and power supply.

The thyratron storage unit, with 12 thyratrons, stores the instantaneous encoder information "on the fly" (within 25 microseconds) so that the encoder can be read while the shaft is in motion. The thyratrons operate relays in the relay matrix to provide the decimal printout.

Some of the encoders available include (1) the C-100 Series with 1000 or 1200 DATEX-coded binary decimal counts/rev.; (2) C-200 Series with 512 or 1024 Gray-coded counts/rev.; (3) C-300 Series with 999-0-999 DATEX-coded counts/rev. or 2048 Gray-coded counts/rev.; (4) geared sets up to 1,000,000 counts, etc.

Fischer & Porter Company

Fig. 9-17 shows the "Digi-Coder" of Fischer & Porter Company. Shaft position is converted into discrete electrical contact combinations.

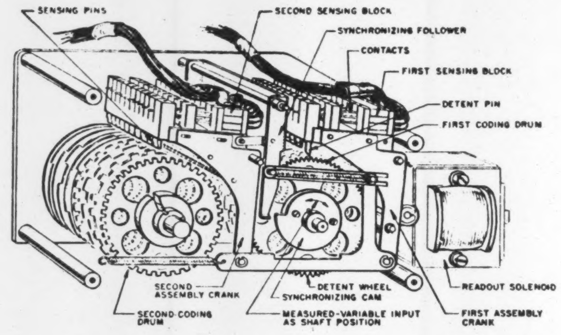

SENSING PINS
SECOND SENSING BLOCK
SYNCHRONIZING FOLLOWER
CONTACTS
FIRST SENSING BLOCK
DETENT PIN
FIRST CODING DRUM
SECOND ASSEMBLY CRANK
DETENT WHEEL
SYNCHRONIZING CAM
READOUT SOLENOID
SECOND CODING DRUM
MEASURED-VARIABLE INPUT AS SHAFT POSITION
FIRST ASSEMBLY CRANK

Fig. 9-17. "Digi-Coder" of the Fischer & Porter Company converts shaft position into discrete combinations of electrical contacts on surface of a code drum.

The input shaft is directly connected to a code drum on the surface of which are machined hills and valleys. Above the code drum is a sensing block which holds a number of sensing pins which actuate simple on-off electrical contacts. When a readout is required, a readout solenoid, electrically actuated, pulls the first assembly crank to bring the sensing block down to the code drum so that all sensing pins are either in or out, depending on their respective hills and valleys on the code drum. As every position of the input shaft places a unique configuration of hills and valleys beneath the sensing pins, the open and closed circuits are a coded digital expression of the value of the measured variable represented by the input shaft position at time of readout. A ratchet wheel prevents ambiguity by pulling the pins into an adjacent desired position.

The unit is available with a resolution of six digits. The maximum sampling rate with the sensing blocks described is three per second. Magnetic sensing blocks are available for continuous readout.

Remington Rand Univac

Remington Rand Univac offers the "Digiverter" (Fig. 9-18) which contains two segmented commutators and

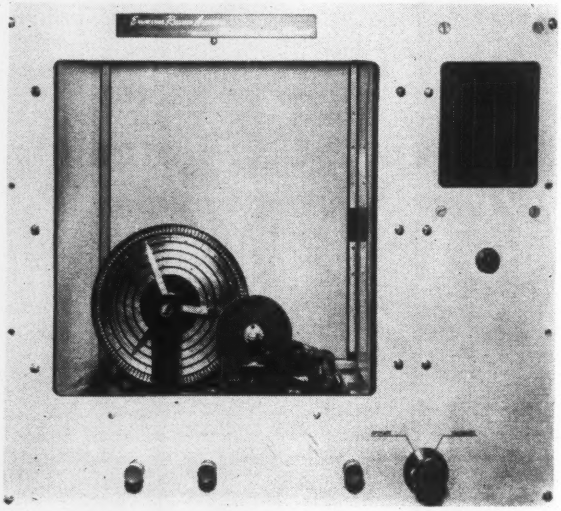


Fig. 9-18. The "Digiverter" offered by the Remington Rand Univac uses segmented commutators and brush assemblies for data printing or decimal readout.

corresponding brush assemblies. One set of brushes is connected directly to a servo motor, the other set is coupled to the motor through reduction gearing. The servo motor is positioned from a control synchro positioned by the shaft position to be digitized; the output consists of contact closures representing 5 parallel decimal digits. After the servo system is balanced, the brushes are brought into contact with the commutator to produce the output. A digit-justifying mechanism prevents ambiguity.

Resolution is 1 part in 6250; response time is 1 second to balance servo that follows the input shaft motion.

Streeter-Amet Company

Streeter-Amet offers the "Ametron" line of digital printers for weight, temperature, force, and other industrial variables. The devices are essentially shaft-position quantizers. The shaft is the servomotor or potentiometer shaft that is a measure of the variable to be digi- zed. The shaft position is converted into discrete digits n a type wheel by step-cam and sensing fingers, as shown 1 Fig. 9-19. The sensing fingers can be used also to oper- te a bank of wiping switches, each of which has ten ontact positions, representing the numbers 0-9. These ectrical signals are used to operate electric typewriters, ipe punches, etc.

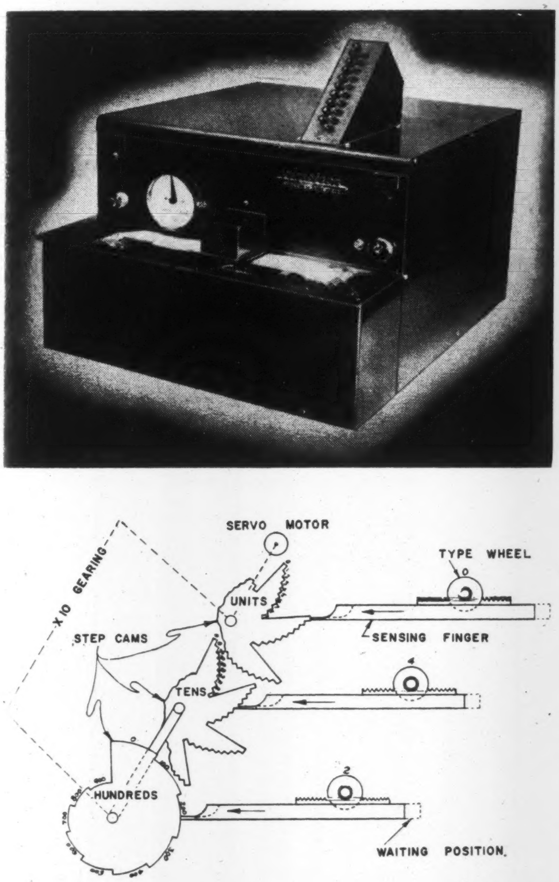


Fig. 9-19. "Ametron" line of Streeter-Amet digital rinters uses step-cams and sensing fingers.

Taller & Cooper, Inc.

The Taller & Cooper Type P (Pulsing) digital converter (Fig. 9-20) consists of four step-type cams and a read-out section composed of four mechanical fingers with associated contacts. The fingers advance during the reading cycle until they are stopped by the depth of the cam step. During this travel, the contacts transmit the digital reading to the remote recorder.

Each digit sensed by the fingers as they are cycled by the motor (M) is dispatched as a series of pulses (1-9). These pulses may be used to set up printing wheels or stepping switches for direct recording of the actual digits or their conversion into some other form of code.

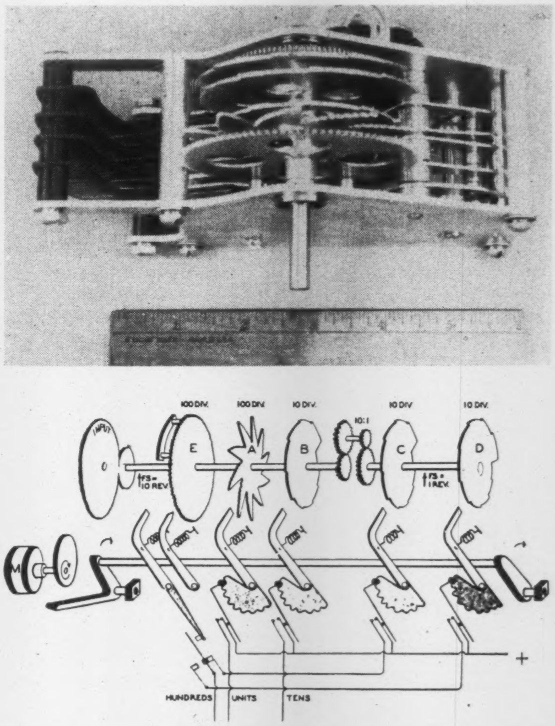


Fig. 9-20. Taller & Cooper digital converters also use step-cams and mechanical fingers for digital printing.

A Type N.P. (Non Pulsing) digital converter also consists of four step cams and a readout section composed of four mechanical fingers with associated contacts. During the reading cycles the fingers advance until they are stopped by the depth cut of the cams. In this position the associated contacts have arrived at the correct stations on a three-digit commutator. The basic difference is that instead of a motor that cycles the fingers, a reading is taken only when a solenoid is energized, and the output is a circuit from a commutation contact.

Both types permit up to 1000 counts per second (ten revolutions are required for 1000 counts), and are designed for use with 1-second or 2-second self-balancing potentiometers. They can record 2 or 3 digits. Readout time is 1 second.

All-electronic data loggers and all-electronic high-speed analog-to-digital converters (which complete this discussion of available converters) will be presented next month.—ED.

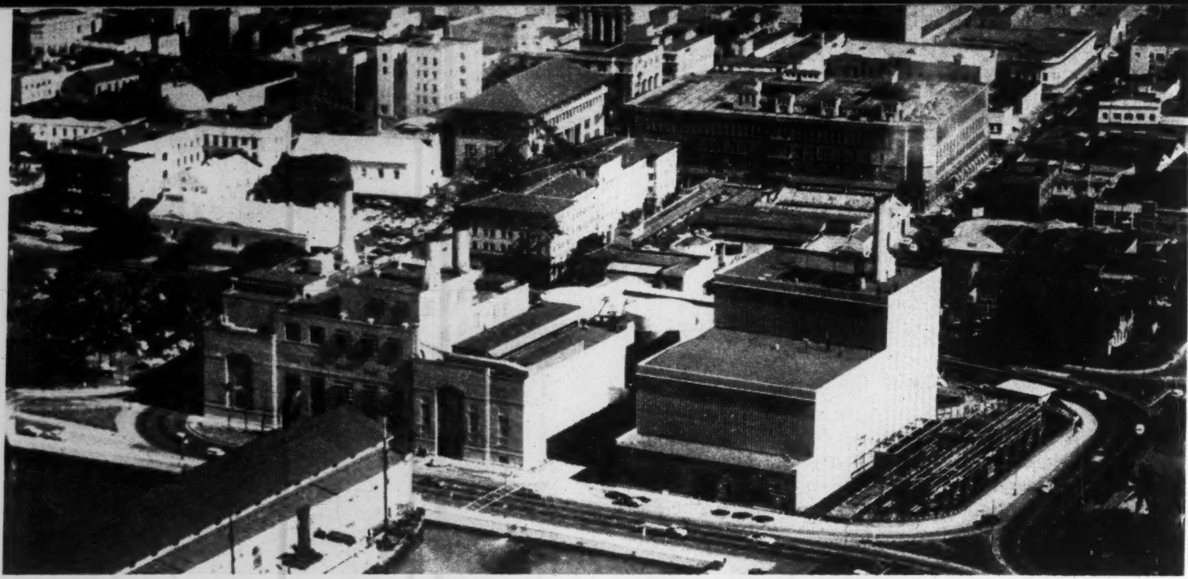


Fig. 1. Aerial view from over harbor shows two Honolulu power plants with Number Eight at right, and downtown portion of city they serve. (Courtesy, Hawaiian Electric Company)

Centralized Control of Honolulu

Centralized control of the new Number Eight Power Station of Hawaiian Electric Company includes interlocked fuel-air combustion control, 3-element feedwater control, fuel-oil temperature control, hydrogen temperature control, air recirculation control, and deaerator level control.

TREMENDOUS growth of population, business and industry on the Island of Oahu during the past ten years is reflected in its increased electrical power consumption. To meet this demand, the Hawaiian Electric Company Limited has put into operation a new 50,000-kilowatt power-generating unit. Known as Honolulu Number Eight, the new unit significantly occupies a site on the harbor front where whaling vessels once discharged cargoes of oil to light the lamps of Honolulu (Fig. 1).

Addition of Number Eight brings the Hawaiian Electric Company's total capacity to 270,000 kilowatts, supplying the homes, the sugar mills, the pineapple canneries, the offices, and the government installations on the Island of Oahu.

Generating Equipment

The steam generating equipment for Honolulu Number Eight is a Babcock & Wilcox 485,000-lb-per-hour single-drum radiant-type unit, having pressure and temperature ratings of 1,500 psi and 950 degrees, respectively. Design engineering was done by Bechtel Corporation, San Francisco, California. Metering and control equipment was supplied by Bailey Meter Company, Cleveland, Ohio. The most modern features of automatic and centralized control were incorporated in the new plant; not a single high-pressure steam, water, or fuel line has been terminated in the control room.

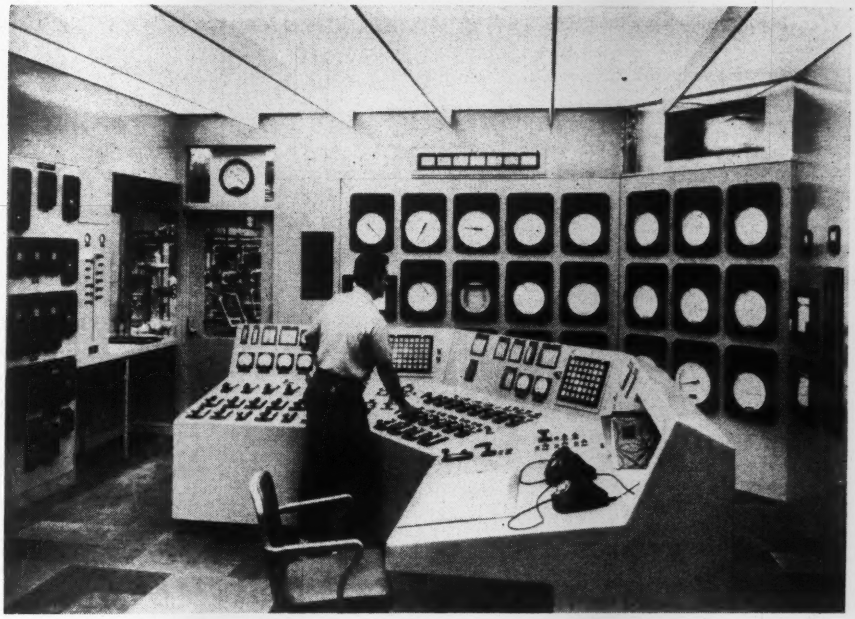
By making extensive use of pneumatic transmission equipment, Number Eight realized three important advantages: (1) a high degree of sensitivity for precise control; (2) centralization of operating information and controls; and (3) safety and minimum piping cost by keeping high-pressure lines out of the control room.

Centralized Control Considerations

Experience has shown that centralization of control improves reliability and performance because of better communication and coordination of man and machine.

Centralized control means much more than just consolidating equipment in one room. Designing a control room such as at Honolulu Number Eight involves consideration of many factors. Most important, the plant's operating philosophy must be determined. How operating personnel are to be used depends on many things, such as type of plant, type of load to be carried, and the background and experience of the operating personnel. The control center must be designed to suit these requirements and considerations.

Fig. 2. Central Control Room of Honolulu Number Eight. (Courtesy, Bailey Meter Company)



Number Eight

FRANK R. MONTGOMERY
Hawaiian Electric Company

and

GEORGE E. LUPPOLD
Bailey Meter Company

As operating personnel are the key to the basic design, let us consider the duties of an operator in a power plant such as Number Eight. His primary duties are threefold: (1) Start up the plant. (2) Run the plant in an "off-normal" manner, when necessary. (3) Supervise over-all plant operation.

The control center should be designed to provide the appropriate information to the operator and to arrange it in a form he can use to best advantage. The indicating, recording, and controlling equipment should have a functional arrangement so that an operator will know instantly if action is needed, and will be able to act instantly.

Arrangement of Control Room

The arrangement of the control room of Number Eight (Fig. 2) is as follows:

(1) Mounted on a vertical panel are recording instruments which show not only the instantaneous value of each variable, but also its trend. A total of forty-five continuous records are provided.

An operator going on duty has a complete picture of the plant's operation for at least the past eight hours. The circular-chart records also provide an easy means of maintaining a day-by-day history of plant operation, and analyzing related factors at any convenient time.

(2) Bailey "MINI-LINE" indicating gages are mounted on the control desk, arranged according to the "GAGE GROUPING FOR POINTER PATTERN" technique. With this technique, related factors such as *steam flow, water flow, drum level, drum pressure,* and *feed water pressure* are indicated by a series of adjacent gages. The normal operating value of each is in the same relative position on its scale. Thus the operator need only scan the indicators to observe abnormal operations in any part of the plant.

(3) When action is required, the operator has remote control of all vital factors literally at his finger tips. Each of the Bailey "MINI-LINE" selector stations, mounted on the control desk, provides a selection switch for changing the control from automatic to manual, and a control knob for altering the pneumatic signals to the final control elements.

Combustion Control System

Fig. 3 shows the automatic combustion control system, illustrating the comprehensive design which characterizes the entire installation.

The purpose of the automatic combustion control is to supply *fuel oil* and *combustion air* in accordance with load requirements and in the *proper ratio* to maintain optimum firing conditions.

The Bailey Pneumatic Combustion Control system operates in the following manner:

1. *Master Control*: A Bailey Master Steam Pressure Transmitter controls the fuel-oil flow, the forced-draft fan and induced-draft fans in parallel and in the approximate desired relationship to each other. Oil flow is regulated by a recirculating valve, and each fan by both inlet vanes and outlet dampers.
2. *Fuel Oil Limit Control*: A fuel limiting signal modifies the master control impulse so as to retard the fuel-oil flow in event the fuel/combustion-air ratio reaches an established limit. This phase of the control system is a safety feature which minimizes the possibility of firing with an extreme deficiency of combustion air at time of

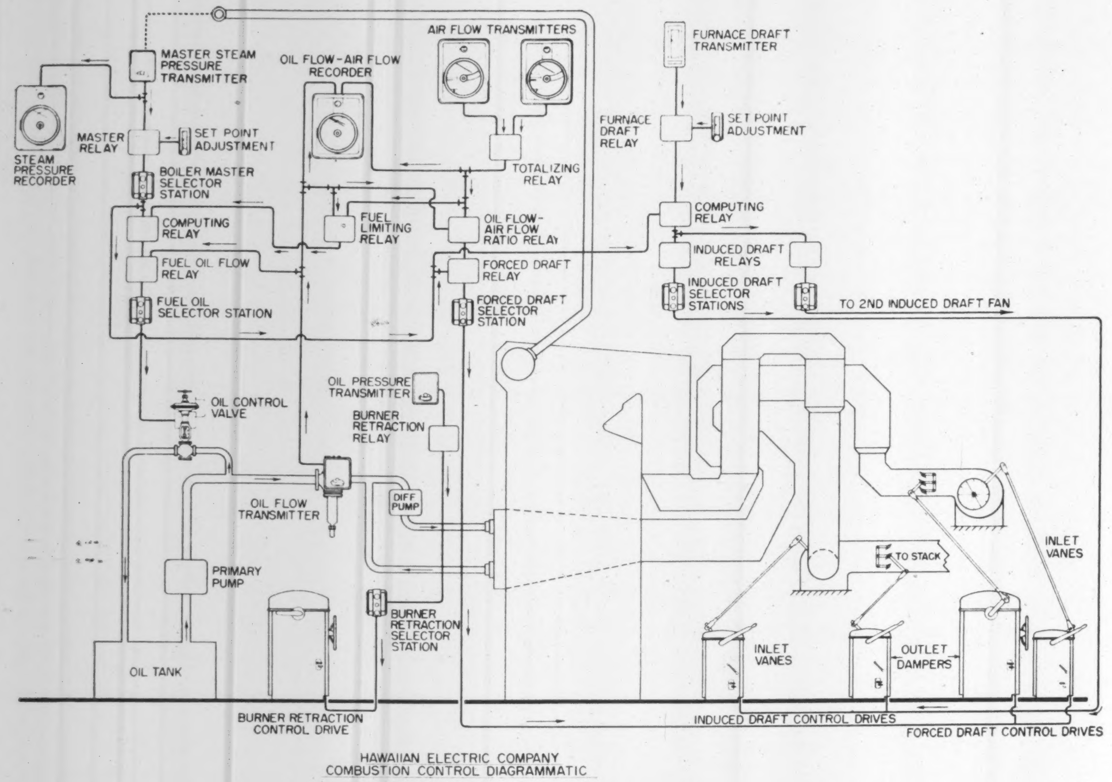

MASTER STEAM PRESSURE TRANSMITTER
OIL FLOW-AIR FLOW RECORDER
AIR FLOW TRANSMITTERS
FURNACE DRAFT TRANSMITTER
STEAM PRESSURE RECORDER
MASTER RELAY
SET POINT ADJUSTMENT
BOILER MASTER SELECTOR STATION
TOTALIZING RELAY
FURNACE DRAFT RELAY
SET POINT ADJUSTMENT
COMPUTING RELAY
FUEL LIMITING RELAY
OIL FLOW-AIR FLOW RATIO RELAY
COMPUTING RELAY
INDUCED DRAFT RELAYS
FUEL OIL FLOW RELAY
FORCED DRAFT RELAY
INDUCED DRAFT SELECTOR STATIONS
TO 2ND INDUCED DRAFT FAN
FUEL OIL SELECTOR STATION
FORCED DRAFT SELECTOR STATION
OIL PRESSURE TRANSMITTER
OIL CONTROL VALVE
BURNER RETRACTION RELAY
OIL FLOW TRANSMITTER
DIFF PUMP
INLET VANES
TO STACK
PRIMARY PUMP
BURNER RETRACTION SELECTOR STATION
INLET VANES
OUTLET DAMPERS
OIL TANK
BURNER RETRACTION CONTROL DRIVE
INDUCED DRAFT CONTROL DRIVES
FORCED DRAFT CONTROL DRIVES
HAWAIIAN ELECTRIC COMPANY
COMBUSTION CONTROL DIAGRAMMATIC

Fig. 3. Combustion control system. Master signal, generated by Master Steam Pressure Transmitter at upper left, is sent to Computing Relays (one for fuel-flow and one for air-flow control). Fuel-oil Limiting Relay modifies the control signal to the fuel-flow controller in event of deficiency of combustion air.

rapid load change or in event of a sudden loss in fan capacity.

3. *Oil-Flow/Air-Flow Ratio*: The master control impulse is readjusted to its final control of the forced draft fan from a signal established as a function of the ratio of the metered fuel and combustion-air flows.

4. *Furnace Draft*: So as to maintain the desired balance between the induced- and forced-draft fan capacities, a Bailey Furnace Draft Controller initiates a readjusting control impulse which modifies the master signal in its control of the induced-draft fan.

In addition to the master steam pressure signal and modifying signals mentioned, a pneumatic signal from a Bailey Oil Pressure Transmitter controls burner retraction to maintain the desired oil-burner position.

Bailey "MINI-LINE" Selector Stations in the control room provide manual control of oil flow, burner retraction, forced draft, and induced draft. A selection switch for "bumpless" transfer from hand to automatic operation is an integral part of each selector station.

In addition to the combustion control and metering equipment described, the Bailey Meter Company also supplied the following systems:

Other Control Systems

1. *Air-operated Three-element Feedwater Control*: Positions feedwater control valve by a primary signal from steam-flow/water-flow ratio with a readjusting signal from drum level.

2. *Air-operated Fuel-Oil Temperature Control*: Regulates steam flow to fuel-oil heaters by a primary signal from oil flow with a readjusting signal from temperature of fuel oil.

3. *Air-operated Hydrogen Temperature Control*: Regulates water flow to hydrogen cooler by a signal from hydrogen temperature.

4. *Electrically-operated Feedwater-Pump Recirculation Control*: Positions recirculation valve by a signal from feedwater flow.

5. *Air-operated Air Recirculation Control*: Positions air recirculation dampers by a signal from the average of the temperatures of air at forced-draft outlet and of exhaust gases at the two air-heater outlets.

6. *Air-operated Deaerator Level Control*: Regulates water flow to deaerator by a primary signal from feedwater flow and a secondary signal from deaerator level.

The Future

The continued growth of Honolulu has necessitated The Hawaiian Electric Company to begin work on a new unit, Unit Number Nine (Bailey Meter Company will furnish the controls for this unit). Preliminary design of the controls has already been completed and it is expected that this unit will go into operation in 1957. Number Nine will in general duplicate Number Eight. Steam conditions and plant capability will be the same. Unit Nine will be shipped with regenerative-type air preheaters instead of tubular type, and the fuel-oil burner pressure will be increased from 900 psi to 1200 psi at maximum load. More extensive use of transmitted impulses instead of high-pressure lines is planned for the new unit.

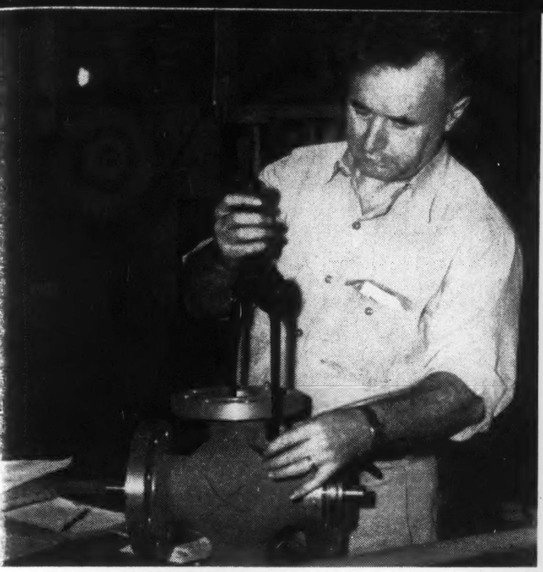


Fig. 1. Checking wall thickness at flange neck.

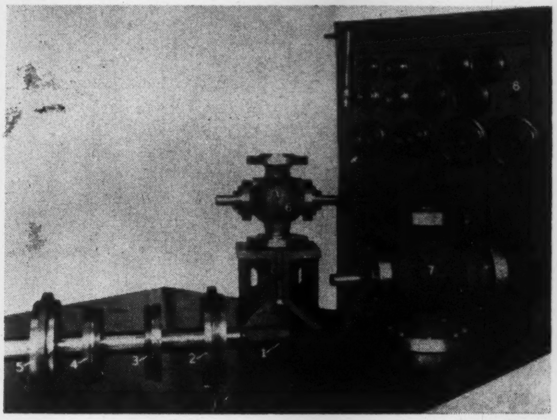


Fig. 2. Array of gages used to check alignment of machined surfaces.

Evaluation of Valve Mechanical Characteristics

To insure proper mechanical operation of valves, the industry has developed a number of check procedures and tests which are performed during and subsequent to their manufacture. The tests which are commonly used to evaluate control-valve mechanical characteristics are described—casting and forging inspection, stem finish, actuator rating, actuator leakage, body rating, etc.

J. T. WARD[1]
and
OTTO KNEISEL[2]

Casting and Forging Inspection

MATERIALS used most commonly for control valves are cast iron, cast steel and forged steel. Both normal and special practices for inspection of castings and forgings exist in the industry.

Iron castings are not 100 percent inspected unless they were made for valves of a new design, a special type, or an order for one or two pieces. Normal inspection is visual on a spot-check basis of, for example, the first item of a lot. The inspection is made to determine if the castings contain sand holes or blow holes which are indications of poor casting quality. The other reason for this inspection is to determine whether dimensional tolerances are met so that when machined the casting will be in conformance with the drawings. Foundries keep on file the physical and chemical analyses of each heat poured.

Steel castings are given more attention than cast iron. Some manufacturers visually inspect every steel casting regardless of lot sizes. Physical and chemical test data are usually required by the valve manufacturer for steel castings.

Steel forgings normally receive only a visual inspection prior to machining and during machining operations. The quality control for forgings is more exact than that possible for steel castings.

When the purchaser requires test coupons they must be ordered with the casting so that they can be supplied from the ladle from which the casting is poured. The coupon flask is placed beside the casting flask at the foundry and is poured concurrently with the casting. Analysis can be made at either the foundry or an independent laboratory.

Radiographic analysis can be used to locate voids and nonhomogeneous spots in the casting. Radiographic Standard for Steel Castings is ASTM E71-52T. Considerable skill and experience are required to interpret the resulting exposure which will show gas pockets and sand inclusions, but may miss cracks or cold shuts. Forgings, originating from billets, cannot be inspected by x-ray techniques; the soft x-rays required will not penetrate the usual thickness.

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[1] E. I. du Pont de Nemours & Co., Wilmington, Del.
[2] Hammel-Dahl Co., Providence, R. I.

Abstracted from ASME Paper 55-A-105, contributed by the Instruments and Regulators Division for presentation at the ASME Diamond Jubilee Annual Meeting, Chicago, Ill., November 13-18, 1955.

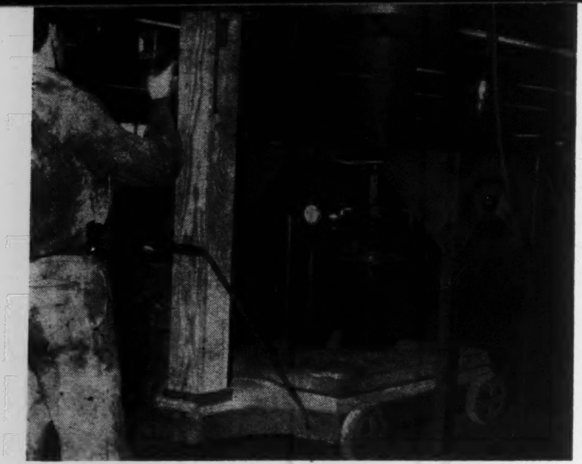


Fig. 3. Spring rate (pounds per inch deflection) is checked by weight scale.

The *magnetic-particle* or Magnaflux method is another special technique. It is used to detect cracks and cold shuts. Since a magnetic material under the influence of a magnetic flux will set up opposite poles on either side of a crack, magnetic particles applied to the magnetized body will concentrate at the cracks, which then become more clearly defined.

A technique similar to this in some respects is called a *dye-penetrant inspection.* The principle: a specific dye applied to the surface of a casting will be least readily removed from the cracks. The principle can be combined with the use of fluorescent materials.

A more recent method which has been used successfully in the inspection of forging billets is called the *sonic method.* The principle involves the comparison of reflected vibrations or echoes. The vibrations are produced and compared electronically.

Destructive tests are sometimes made for high-pressure forgings. A representative forging from a group will be cut in two planes 90 degrees from each other. These surfaces are then subjected to a deep etch test with nitric acid to establish the homogeneity of the material.

Dimensional and Concentricity Gaging in Manufacture

The first dimensional inspection is for conformance to the casting drawing with the given tolerance, and to establish the correct piece number of the casting. This inspection includes (1) a determination of the excess amount of material to be machined off to bring the casting to finished size and (2) wall-thickness gaging to insure the pressure strength of the casting.

Subsequent dimensional and concentricity checks are made throughout the whole manufacturing process. Thread gages, dial indicators with special setups, bore gages, and depth gages are the usual tools. Special gages are used to limit the eccentricity of cylindrical surfaces and relate the angles between plane surfaces. Flanges are drilled with special jigs and fixtures to insure exact location of bolting holes. Flush-pin gages are used to measure the distance between seats on double-seated valves. Visual checks of the casting quality are necessary to detect core shifts and casting shape irregularities.

Stem-Finish Evaluation

The quality of the valve stem finish is closely tied in with valve speed of response. Corrosion of stems has been reduced to a minimum by the use of stainless steel. A fine grind finish on stainless steel is not satisfactory by today's standards. Machines are now used which polish ground stems to a finish of 4 to 6 microinches rms. To insure this quality the stems are inspected by comparison with standard surface-finish blocks, or directly with a surface finish instrument such as the Brush Surface Analyzer.

Pressure Rating of Valve Operator

The basic structural design of the topworks operator is proved by laboratory tests in the original development of the valve. These proof tests during the design stages (with the proper application of safety factors from 3 to 1 or 5 to 1) are used for the first rating. Final tests on the assembled valve usually include a 50-psig (or higher if specified) test in conjunction with leakage testing. As the trend is to higher operating pressure by the use of valve positioners and boosters, stronger and safer designs and materials are being required. A stamped rating such as required on code vessels now becomes desirable.

Diaphragm Testing

Diaphragm material is inspected visually for surface scars, pits or bubbles, and exposure of fabric. It is generally purchased as diaphragm stock, not as a fabric with certain physical properties. Diaphragms usually are not tested for bursting pressure. The principal reason for this is that their relatively high strength is far beyond requirement. Some presently used stocks have a 425-psig bursting pressure on a 2-in-diam circle. The fabric is either nylon or rayon with rubber, neoprene, silicone rubber, or other similar materials.

Spring Tolerances

Control-valve springs are usually bought to ASTM Specification A-125-52. This specification covers the complete design of the spring, including material, strength calculations, finish, etc. Spring rates within ± 5 percent of specifications are acceptable. Squareness to within 1½ deg is required. Springs must be able to go solid without permanent set. Specifications written by purchasers frequently require the valve span to be 3 to 14.5 ± 0.5 psi or within ± 4.2 percent. User's specifications are then met by selective fitting of the spring to the operator.

Operator Leakage Testing

Topworks leakage testing is a common requirement. Air at 50 psig pressure is applied to the diaphragm case. Joints can be covered with soap solution and bubbles for leak testing. Another method involves pressure lock-up and loss of pressure over a period of time. A third method, and one used particularly for stem seal on air-to-open topworks, uses a bubbler in the air supply to the topworks in series with a regulator to maintain pressure. This test is of particular importance to the user because of the effect on the control time-lag due to leakage.

Pressure Rating on Valve Bodies

All valve bodies are hydrostatically tested for body pressure ratings in accordance with ASA Specification B16.5-1953. While the specifications require that cast-steel bodies be tested to 1½ times the 100°F rating, and cast iron to twice the rated steam pressure, actual practice varies somewhat. The test pressure is held approximately 5 min. Cast-steel bodies are tested up to 3 times the primary service rating.

The ASA specification ratings are complete, giving test pressures for every rating. These ratings are very conservative to allow for piping stresses and a long service life. There is a need for extending the rating service since new processes are creating new operating pressure levels. Valve manufacturers usually test each body hydrostatically at least three times: the unmachined casting, the finished body, and the assembled valve.

Where test pressures are limited by special devices (such as bellows seals) it is customary to test valve casting and machined body at the body rating without the bellows seal. Later the assembled valve is hydrostatically tested at the rated maximum pressure set by the bellows manufacturer. This rating is, at present, a maximum of 600 psig. The bellows themselves are bubble tested on receipt from their suppliers and again air-leak tested on final assembly.

Hysteresis Testing

Valve motion hysteresis is undesirable since it directly limits the quality of automatic control. A hysteresis test gives the cumulative effect of clearance, misalignments and eccentricities. However, since it is not made under operating conditions it is not a positive method of establishing operating hysteresis. The test yields only a useful relative value. A few of the larger users require every valve to be hysteresis tested. This accounts for about 20 percent of the valves manufactured; the balance are spot checked.

There are two general methods of testing for hysteresis. One method uses a time-cycle device to pressure the valve, with a motion transmitter on the valve stem. The two values of pressure and travel are recorded on a 15-min circular chart.

The other method uses a manometer and a dial indicator to measure stem motion (Fig. 4). The increment or decrement of pressure change required to move the valve from any given position of travel for 0.001 inch is a measure of valve hysteresis at that point. The check points are usually 25, 50, and 77 percent of stem travel both upscale and down.

The hysteresis of the valve may change after shipment and installation. Excessive bumping and handling can affect the alignment of parts. Line stresses also can increase the hysteresis after installation. It is interesting to note, however, that the dynamic properties of the fluid handled or of the environment of the valve decrease the hysteresis by keeping the stem in slight motion.

Port Leakage Test

Although a control valve is designed for throttling control most valves are tested to determine the amount of port leakage. Frequently, while in service (or in an emergency) it must function as a stop valve. A typical specification in use governing port-leakage testing is shown in Table 1. Leakage tests shall be made with air pressure applied tending to open the valve.

Table 1 Port-Leakage Testing Specifications

Type	Pressure drop or Test Pressure psig	Diaphragm Pressure			Leakage at tight shut-off: % of actual maximum valve capacity
		Full stroke open	Closed	Tight shut-off	
Double seated up to & including 8 in.	50	3 15	15 3	12 0	0.1
Single seated 1 in.	50	3 15	15 3	18 0	0.01
Single seated up to & including 2 in.	50	3 17	15 5	20 0	0.01
Single seated 3 in. to 8 in.	20	3 18	15 6	21 0	0.01

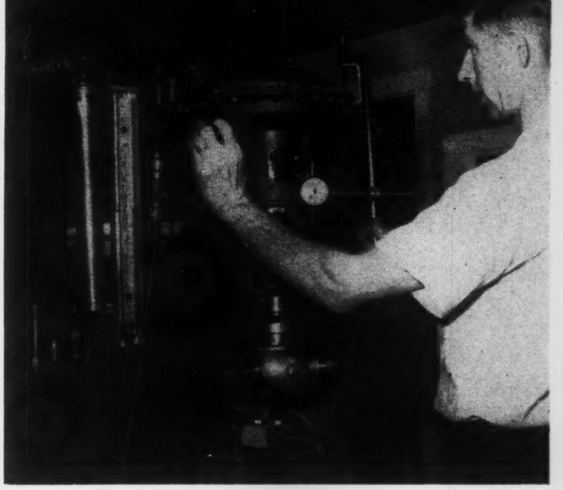


Fig. 4. Hysteresis is determined by observing manometer and dial gage.

It is interesting to note the interdependency of spring windup and size in the single-seated valve. In this case the valve referred to is the conventional globe type.

The permissible leakages indicated are of the most stringent variety and will vary from one specification to another up to 0.5 percent for double-seated valves (basic minimum capacity). Single-seated valves are specified to be bubble-tight for special applications. This means that air leakage is less than the amount that can be observed by collection under water in a bubble. A mass-spectrometer leak detector (which incidentally has been required in at least one instance known to the authors) would still indicate "bubble-tightness" as a measurable leakage.

Valve Travel

All valves are checked for their travel. The actual tolerances are usually minus 0 plus 1/16 in. A very important part of this evaluation lies in one other test—that is, the diaphragm pressure required to obtain this valve travel. A typical specification would read:

"After testing, single- and double-seated valves should be set to stroke from 3 to 15 psig or 15 to 3 psig and valve travel checked from full-open to full-closed position as follows:

"On air-to-close type valves, the valve should start closing when the air pressure on the diaphragm reaches 3 psig (not less). The closing action should continue as the air pressure is increased and valve should be fully closed at 15 and not more than 15.6 psig. Note, however, fully closed position should not be reached until pressure on diaphragm is at least 14.4 psig.

"On air-to-open valves which are spring closed, the valve should start opening at 3 psig (not less) and should be fully opened with 15 psig and not more than 15.6 psig air pressure on diaphragm. Here again, fully opened position should not be reached until at least 14.4 psig air pressure has been applied to the diaphragm."

Pressure-Drop Stability

No routine tests are made to determine pressure-drop stability although maximum pressure drops are appearing in users' specifications. At present, stability is predicted on the basis of experience, periodic laboratory flow testing, and calculations.

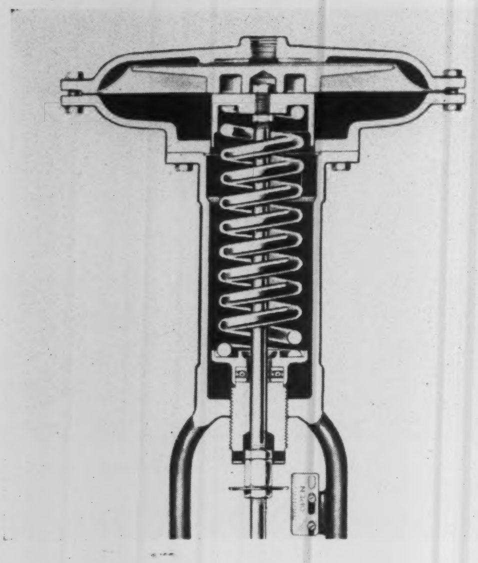


Fig. 6-1. Spring and diaphragm actuator with spring below the diaphragm. Pressure on diaphragm positions stem against compression of the spring.

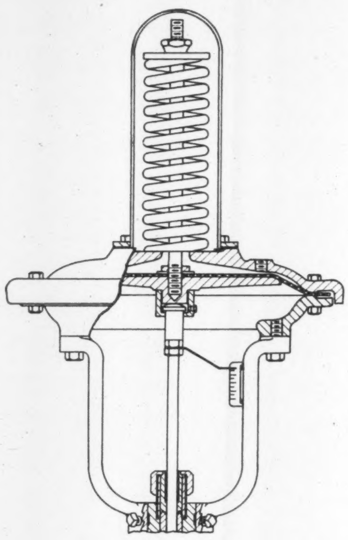


Fig. 6-2. Stem reaches to the upper end of spring when spring is above the diaphragm and loading pressure is applied on top of the diaphragm.

Control Valves—No. 6

PNEUMATIC

The advantages of pneumatic valve actuators include simplicity and time proved performance. Common actuators include the spring-and-diaphragm, weight-loaded, pneumatic-loaded, springless-diaphragm, and cylinder actuators. Diaphragm area factors are emphasized.

A DIAPHRAGM actuator reacts to an external pressure impulse, which may be either the output pressure of a controller or the static pressure from the fluid passing through the valve. A typical spring-loaded diaphragm actuator is shown in Fig. 6-1. In this design the spring is located *below* the diaphragm (between the diaphragm plate and an adjusting nut by which the initial compression of the spring can be changed). Pneumatic or hydraulic pressure applied on top of the diaphragm will move the stem.

Fig. 6-2 shows a design in which the spring is located *above* the diaphragm. This design facilitates adjustment of the spring, which is made by shutting off the pressure line to the diaphragm and removing the spring housing. No stem guides are used because alignment is obtained by the spring suspension and flexible stem connection.

The actuators shown in Figs. 6-1 and 6-2 cause the stem to move downward with increase in applied diaphragm pressure. Where the actuator must raise the valve stem when the diaphragm pressure is increased, the pressure inlet is made *below* the diaphragm rather than above. (In this "reverse" actuator, the design is such that increased operating pressure is still opposed by compression of the spring.) Many pressure regulators of this latter type apply the controlled pressure to the diaphragm directly from the body and there is no need for a packing gland around the stem, as shown in Fig. 6-3. In this design a side-mounted spring opposes the movement of the diaphragm by use of a toggle arm.

Spring and Diaphragm

The position of the stem of a spring-and-diaphragm actuator depends on (1) the effective area of the diaphragm, (2) the pressure on the diaphragm, (3) the force of the spring at the particular degree of compression, (4) the pressure drop across the seats, (5) the hysteresis due to guides and packing, and (6) the weight of moving parts. All these factors affect the positioning.

Excerpts from valve specifications of a large oil company emphasize the importance placed on the spring-diaphragm operation. The specifications (for this one company) state:

"*Hysteresis*—Valve shall be tested for response with atmospheric pressure on body and with stuffing box loosened. At any stroke position, a 0.3-psi change in either direction must cause valve to move. Valve shall be checked for hysteresis at 5 psi, 9 psi, and 13 psi loading pressures.

"*Valve Travel*—Valve travel should be checked from full open to full closed position as follows:

a. On direct type valves, the valve should start closing when the air pressure on the diaphragm reaches 3 psi (not less). The closing action should continue as the air pressure is increased and valve should be fully closed at 15 psi and not more than 15.6 psi. Note, however, fully closed position should not be reached until pressure on diaphragm is at least 14.4 psi.

b. On reverse acting valves (which are spring closed) the valve should start opening at 3 psi (not less) and should be fully opened at 15 psi and not more than 15.6 psi air pressure on diaphragm. Here again, the fully opened position should not be reached until at least 14.4 air pressure has been applied to the diaphragm."

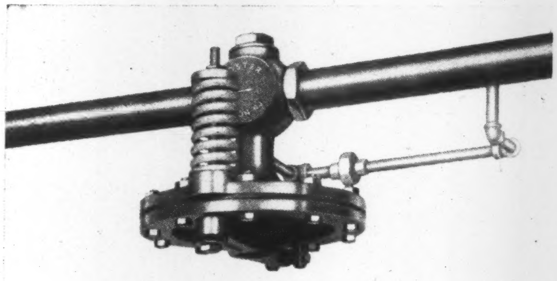


Fig. 6-3. Side-mounted spring opposes diaphragm movement by use of a toggle arm in this regulator. No packing gland is needed because control pressure is applied directly to the diaphragm.

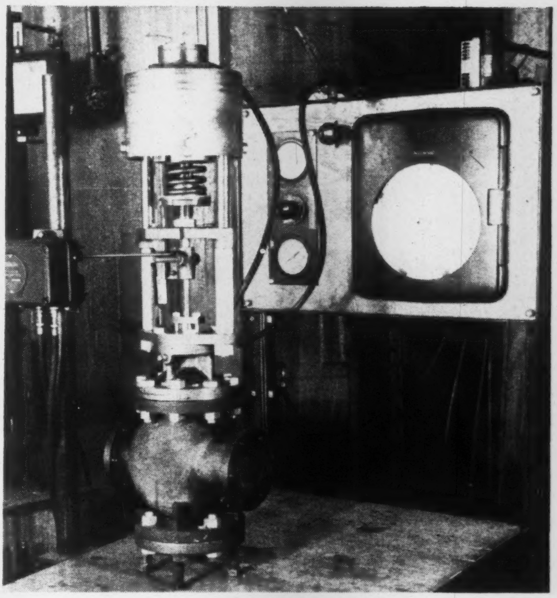


Fig. 6-4. Test setup for checking stem position vs diaphragm pressure. Position transmitter is shown at left.

ACTUATORS

C. S. BEARD

Foster Engineering Company

Control valves usually have a relatively long stem travel, and stem position must be linearly proportional to pressure (usually 3 to 15 psig) on the diaphragm. Test procedures usually specify that the maximum deviation from linearity should not exceed 5 percent of total travel. A test bench to check stem position vs diaphragm pressure is shown in Fig. 6-4. In contrast, the stem travel in a pressure regulator is usually short and this linear relationship between applied pressure and stem position is not required; the spring used is not usually calibrated but is simply compressed to the point required to maintain the desired output pressure.

A different spring is necessary for each size of diaphragm, range of operating pressure, and stem travel.

The Diaphragm

Diaphragms were made in the past of rubber or leather. The preferred diaphragm material is now nylon or duck centered between layers of neoprene or synthetic rubber. A diaphragm of this sort can be thinner and still retain its strength.

Fig. 6-5 illustrates how the effective area of a diaphragm changes from a maximum in the upper position (D_1) to a minimum in the lower position (D_2). This change in effective area has an appreciable effect in a pressure regulator (which is a pressure-to-close valve). The diaphragm will be in the extended position under *low*

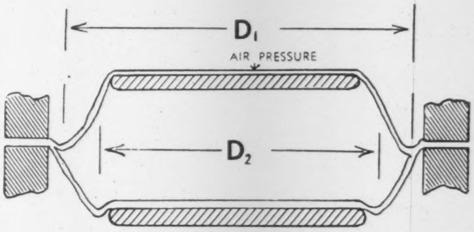


Fig. 6-5. Effective area of diaphragm in upper position is greater than area of the same diaphragm in the lower position when the applied pressure is above the diaphragm.

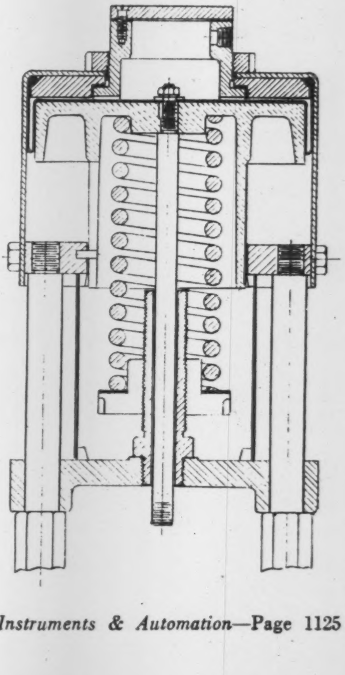


Fig. 6-6. Small-convolution diaphragm (Bellofram) allows any desired travel with no change in effective area of diaphragm.

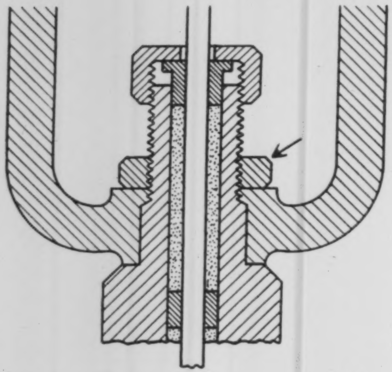


Fig. 6-7. Locknut (arrow) locks bonnet to superstructure.

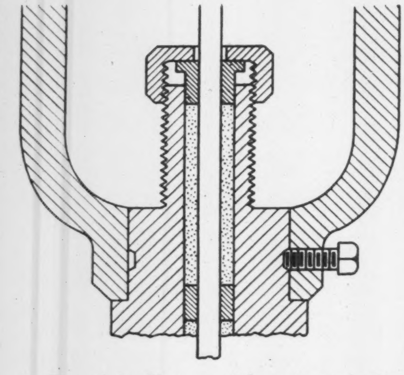


Fig. 6-8. Sleeve with set screw is another method for joining superstructure and bonnet.

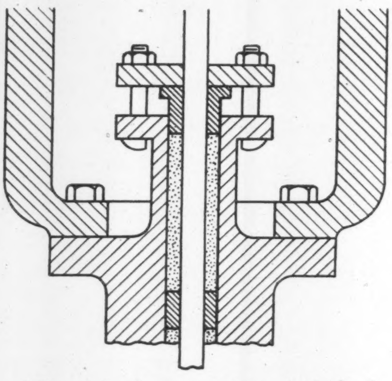


Fig. 6-9. Superstructure is bolted to bonnet in this construction, which is used in large valves.

flow conditions. The line pressure required to balance the weight or spring setting will be a maximum in this position. As the line pressure in this type of valve is the controlled pressure, it will be abnormally high. When the valve opens with higher flow, the effective area of the diaphragm increases, thereby requiring less pressure to counteract the weight or spring. The controlled pressure will thus decrease as flow increases.

In most piping systems this is not a desirable condition because increased flow causes increased pressure drop, which in turn requires higher, rather than lower, output pressure.

The change in effective area of a diaphragm is equally undesirable in control-valve actuators. The stem travel of the control valve is at least twice that of the regulator. This requires a large annular space between the diaphragm plate and the inside edge of the diaphragm case to allow free movement of the diaphragm. Molded diaphragms are used to obtain the desired travel. However, the diaphragm still varies in effective area, and in the lower position (when the spring is compressed to its maximum) the diaphragm force output is less than desired. This means that the applied loading pressure to close the valve must be higher than the value given by the calculations, which assume a constant diaphragm area.

A patented deep-convolution diaphragm (Bellofram) is designed to eliminate this change in effective area. The actuator using such a diaphragm (Fig. 6-6) resembles a piston, but must be considered as a diaphragm actuator rather than a piston actuator. The effective area does not change because the convolution of the diaphragm has the same shape throughout its travel. This actuator provides a true linear relationship between travel and operating pressure.

The inside diameter of the diaphragm case is only ½-inch greater than the diaphragm. This decreases the size and weight of the actuator, particularly for large valves with large effective diaphragm area where a long

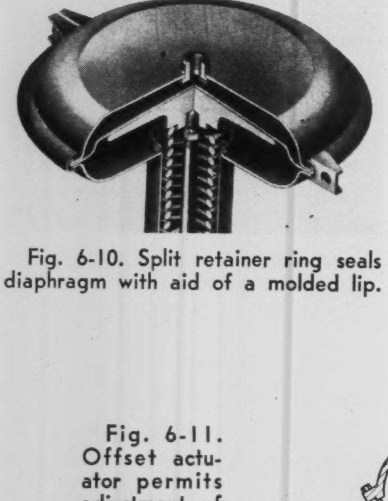


Fig. 6-10. Split retainer ring seals diaphragm with aid of a molded lip.

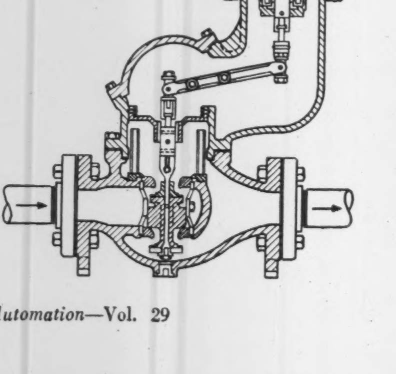
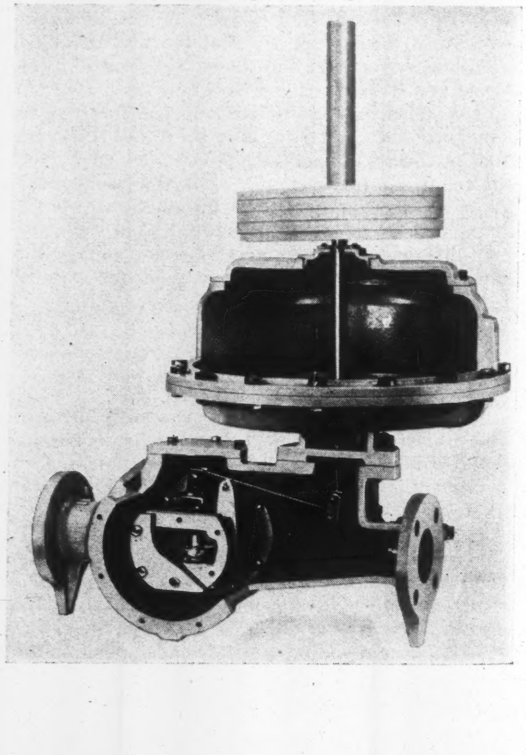


Fig. 6-11. Offset actuator permits adjustment of the power output of the actuator by changing the fulcrum position of the rocker arm.

Fig. 6-12. Setting of weight-loaded regulators can be changed by changing the weights on the stem.



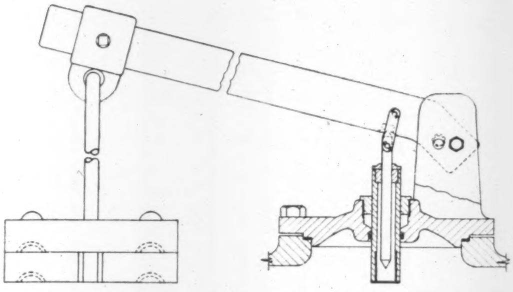


Fig. 6-13. The weights on this weight-loaded regulator are hung from an arm. The setting can be changed either by changing the weights or adjusting the arm length.

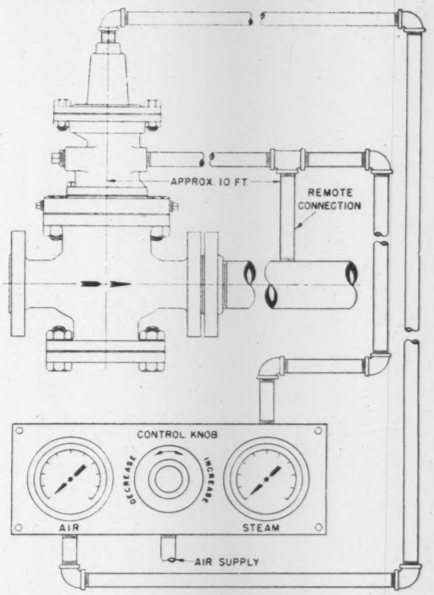


Fig. 6-14. In this air-loaded steam regulator the set-point knob controls the loading air pressure applied to the top of diaphragm. Outlet steam pressure is applied to the bottom of the diaphragm.

stem travel is required. The travel of the type of actuator shown in Fig. 6-6 can be made as long as the diameter of the diaphragm.

Construction of the Diaphragm Actuator

A typical diaphragm actuator consists of two main parts—superstructure and diaphragm case. The superstructure can be a single casting or an assembly, of steel or cast iron. A yoke made of cast iron will not bend to cause misalignment of the stem, but it will break under impact. Steel can bend, but will withstand heat or mechanical shock and has superior strength. Some refineries specify iron only, whereas Navy specifications require steel because of the high shocks encountered in service and in testing for service. Bronze and aluminum are used to a limited degree.

Under any circumstances, actuator design must take into consideration its inevitable use as a ladder. Maintenance men cannot resist climbing on the superstructure to reach high objects. This calls for a strong connection between bonnet and superstructure. The connection may consist of a locknut (Fig. 6-7), a sleeve with set screw (Fig. 6-8), or bolting (Fig. 6-9). Bolting is required for large valves. There must be sufficient space between the side pieces of the superstructures to allow easy removal of the actuator and adjustment or renewal of packing.

Most specifications require that the spring be covered to avoid the affects of corrosive or dirty atmospheres.

The superstructure includes some means for adjustment of the spring, as shown in Figs. 6-1 and 6-2. Some designs base the spring on a ball thrust bearings; others use a Teflon washer to facilitate rotation of the spring under compression.

Diaphragm cases are made of cast iron or steel. Cast or pressed steel cases are generally lighter than cast iron cases. Aluminum is becoming popular.

The usual way of clamping the diaphragm is by bolts around the periphery of the case passing through the diaphragm. Another design (Fig. 6-10) uses a split retainer ring, obtaining a self-sealing action with the aid of a molded lip around the diaphragm.

The design shown in Fig. 6-6 requires no bolts to hold the diaphragm; a retainer plate secures the bead around the periphery of the diaphragm against the inside of the case. The plate is held against the case by the adapter piece, which is drawn into place by a locknut.

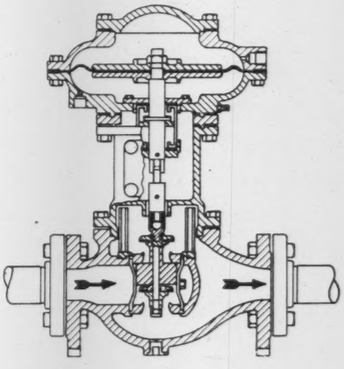
Control valves are available with the actuator offset from the body (Fig. 6-11). This construction permits adjustment of the power output of the actuator by changing the fulcrum position of the rocker arm.

Weight-Loaded Regulators

The diaphragm of a regulator can be loaded by weights instead of air pressure or spring force; the setting of regulator can be changed simply by changing the weight. This can be accomplished by placing wafers directly on the stem (Fig. 6-12) or by hanging weights on an arm (Fig. 6-13); the loading of the latter can be varied easily by moving the weight holder on the arm. The weights can be made to lift the stem, rather than depress it, simply by reversing the arm so that the pivot point is between the weight and the stem connection.

Weight loading has the advantage of being constant at any position of stem travel. Therefore, it cannot be used to balance the variable loading from an instrument controller, as can a spring which exerts a force which varies for each different stem position. Thus the spring rate makes possible a true control valve; a weight-loaded valve can be only a regulator.

Fig. 6-15. Diaphragm case of this regulator permits conversion to spring, weight, or pneumatic loading.



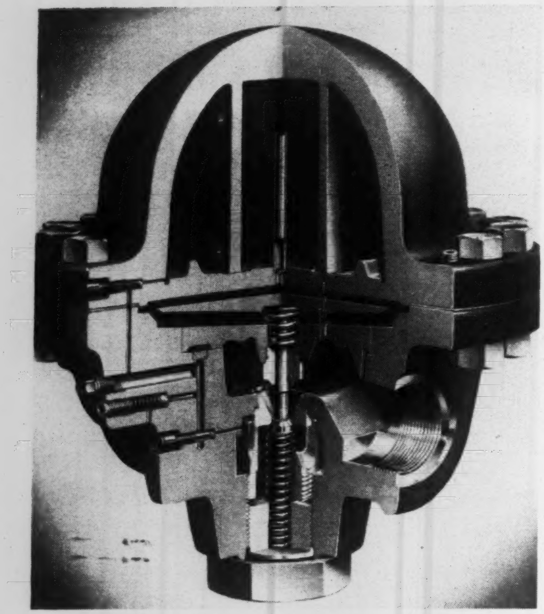


Fig. 6-16. Needle valve locks pressure in dome, which has sufficient size that diaphragm motion does not appreciably alter loading pressure.

Pneumatic Loading

Pneumatic or hydraulic pressure can be used instead of spring or weight loading. Use of air or gas is more common than use of liquid. In the steam-pressure regulator shown in Fig. 6-14, air is introduced into the chamber above the diaphragm at a constant pressure as established by the set-point control knob.

Construction of the diaphragm case of the regulator shown in Fig. 6-15 permits conversion to spring, weight, or pneumatic loading.

A pilot loading regulator (with a small continuous bleed either as a part of the regulator or through a needle valve or a fixed orifice) is often used as the source of loading pressure. Fig. 6-16 shows a design in which the pressure is built up in a dome and then locked in. The volume of the diaphragm case chamber will vary with movement of the diaphragm, but this change in volume will not vary the loading pressure when using the pilot system. As the locked-in pressure will vary, the regulator must be designed with enough volume so that the movement of the diaphragm will not cause a change exceeding the operational requirements of the regulator.

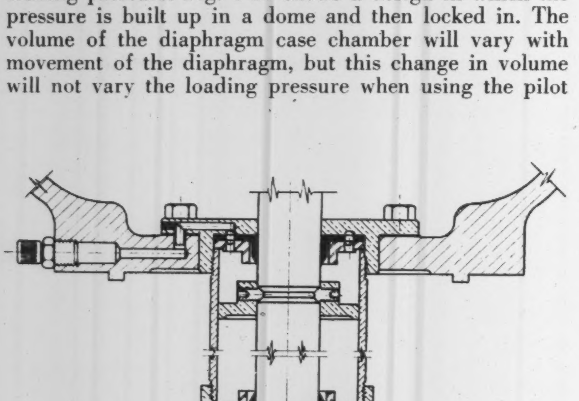


Fig. 6-17. Stabilizer unit assembly for damping valve action uses oil-filled dashpot and stabilizer piston.

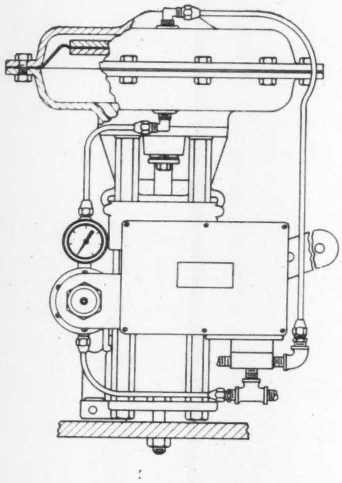


Fig. 6-18. Pressure loading is used on both sides of the diaphragm in this springless actuator.

The pneumatically loaded regulator is sensitive to load changes or pressure fluctuations. Damping can be accomplished by a stabilizer (Fig. 6-17) consisting of a piston (part of the stem) moving in an oil-filled dash pot. The small capillary entrance shown in Fig. 6-16, from the dome to the diaphragm chamber, also has a stabilizing influence. Additional damping also occurs naturally when the plug is close to its seat, at which time the diaphragm is close to the plate which separates the dome chamber from the diaphragm chamber in Fig. 6-16. A small volume of compressible gas resists compression more than a large volume; thus the tendency of the inner valve to cycle (chatter) between closed and slightly open is reduced.

Springless Diaphragm Actuator

Air loading can be used in the operation of an actuator to position the plug in response to the output of a controller or a remote manual loader (Fig. 6-18). In this case, air replaces the spring.

The disadvantage of a spring is that its force is a constant at any one position; it cannot overcome varying friction and differential-pressure forces. Therefore, for true positioning of a spring-diaphragm-actuated valve over a wide range of force variables, a valve positioner is required to modify the diaphragm pressure in order to obtain the desired stem position.

If a constant air pressure is substituted for the spring, the loading pressure is determined by consideration of three operating conditions: (1) Will unbalance in the valve body (such as higher pressure on the underside of the seat) always cause upward movement of the stem? (2) Will the stem always tend to move downward when the high pressure is above the seat? (3) Will there be any reversing forces, such as in the double-seated valves—or (a similar condition) will there be friction resisting movement in either direction, as in a plug cock? These considerations dictate the loading power that must be available in one direction by increasing diaphragm pressure above the diaphragm, and in the opposite direction by decreasing this applied pressure below the diaphragm.

Stem position in a springless-diaphragm-actuated valve cannot be calibrated against pressure above the dia-

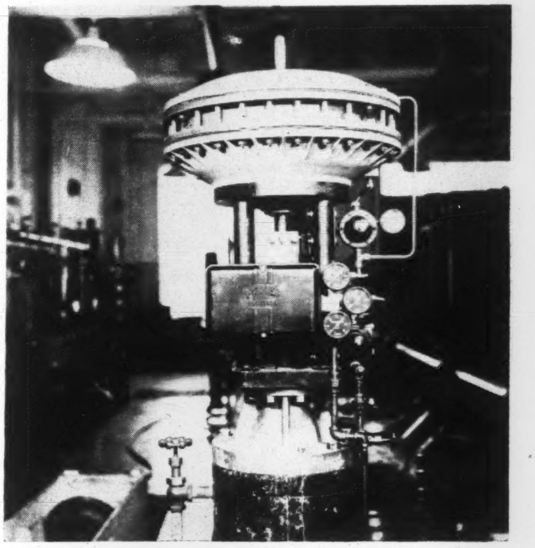


Fig. 6-19. Typical springless-diaphragm actuator comprises diaphragm unit, valve positioner, reversing relay, and air supply regulator. Operation is shown in Fig. 6-20.

phragm, as is commonly done with the spring-loaded diaphragm actuator; the pressure *difference* must be considered.

The springless actuator develops power almost equal to the *maximum* supply pressure times the effective diaphragm area. The pressure on both sides of the diaphragm varies; one decreasing as the other increases and vice versa, so that the sum of the two pressures always equals the supply pressure.

Use of a valve positioner (described in a following chapter) is indicated to take full advantage of the springless actuator. With the positioner, any reasonable pressure can be applied to the diaphragm, still retaining the conventional 3-15-psi controller-output pressure range.

The control system in Fig. 6-19 consists of the diaphragm actuator in the case (with the stem passing through a packing gland), a valve positioner, reversing relay, and air supply regulator. Operation (Fig. 6-20) is as follows: Instrument output pressure (which determines the position of the actuator as shown by the "instrument" gage), opens the pilot valve of the positioner. The pressure on top of the diaphragm as well as below the top diaphragm of the reversing-relay is thus increased. The two-to-one ratio of the reversing-relay diaphragms allows this pressure increase to open the exhaust valve of the reversing relay, with a resulting decrease of the pressure in the lower chamber. These combined actions cause the stem to move downward (thereby compressing the positioner spring) to close the pilot valve of the positioner. Pressure above the actuator diaphragm increases, and pressure below the actuator diaphragm decreases, until the stem assumes the position called for by the instrument pressure.

In event of loss of instrument air, valves operated by springless motors assume a position depending on direction of flow, pressure drop, and weight of parts. Various means (described in a following chapter) are used to hold the valve in a safe operating position upon loss of instrument air.

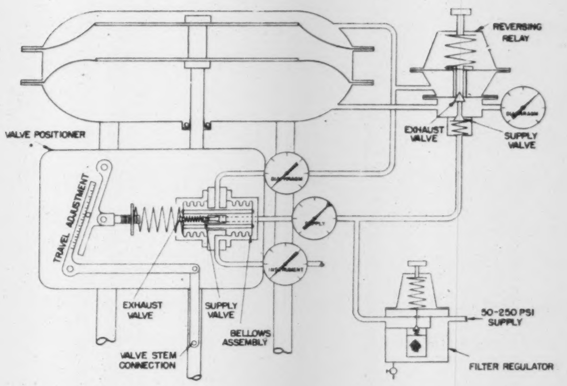


Fig. 6-20. Elements of springless diaphragm actuator with valve positioner and reversing relay.

Cylinder Actuators

Use of hydraulic or pneumatic pressure to move a piston within a cylinder is one of the oldest and most common methods of valve actuation. The cylinder actuator positions a stem which is brought out of the cylinder through a packing gland.

In a *spring-loaded cylinder actuator*, pressure is used only at one end, moving the piston against a spring which returns the piston to its original position upon release of the pressure.

A four-way valve can be used in a *springless cylinder actuator* to admit pressure at one end while the other end is being relieved. Reversal of the four-way valve will re-

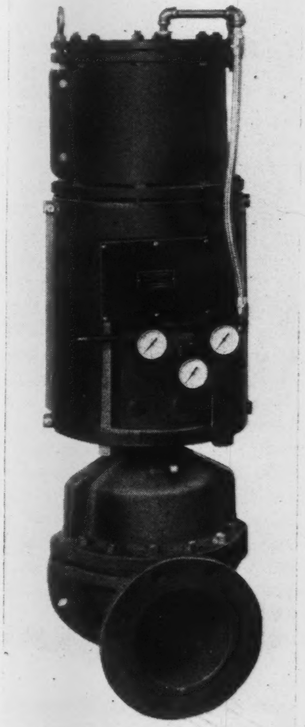


Fig. 6-21. Cylinder actuator mounted on bonnet of Saunder valve body.

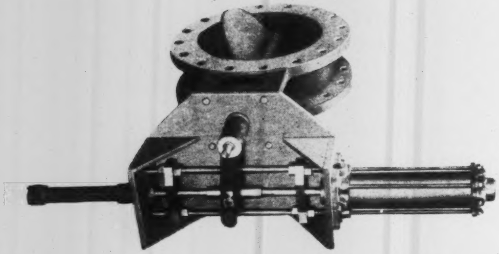


Fig. 6-22 Linkage between this butterfly valve and piston actuator accommodates linear motion of actuator to rotary motion of valve shaft.

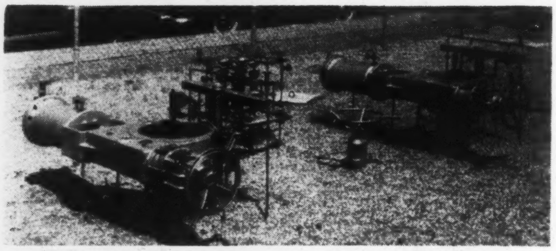


Fig. 6-23. Cylinder actuator operates plug cock, buried to decrease noise.

verse the piston movement. A four-way valve will move the piston to one end or the other, unless an intermediate dead space in the pilot is used to allow pressure to be locked into the cylinder at intermediate positions.

Methods of attaching cylinder actuators depend on the type of valve to be positioned. The actuator can be mounted on the bonnet of a Saunders-type or globe-type control valve body in the same way as a diaphragm actuator is mounted (Fig. 6-21). The cylinder can be mounted on a bracket to operate a butterfly valve (Fig. 6-22); a linkage between the cylinder stem and operating arm of the butterfly valve takes care of the lateral movement as the arm moves through the required angle. The cylinder can be suspended from a pivot to accomplish the same objective.

Plug cocks can be positioned by using a cylinder (Fig. 6-23) mounted on a bracket attached to the body of the valve. Additional force can be obtained by using two cylinders in tandem.

In the past, use of a cylinder actuator usually implied high pressure (either hydraulic or pneumatic) to overcome the high friction needed for sealing the piston, and on-off action was usually indicated. Today, however, extreme care in finishing the inside surface of the cylinder, selection of low friction seals (such as "O" rings), and the advent of the valve positioner have extended the application of the cylinder actuator to many control situations. Figs. 6-24 and 6-25 are representative of these refined cylinder actuators. They are made of special aluminum alloys, bored and honed to ultra-high interior finishes, and subsequently hardened to prevent damage to operating surfaces. An "O" ring is used for sealing the piston. Casting and machining techniques have been developed to obtain highly accurate concentricity.

In Fig. 6-25, vertical stem motion is obtained by two toggle arms which raise the stem when the arms are brought together. The toggle arm can be moved by the cylinder actuator or by a handwheel. A turn-buckle reach arm between one toggle arm and the positioner operates the positioner to supply necessary pneumatic pressure to each end of the cylinder. The reach arm is visible in the picture; it is connected to alarms mounted on the back of the cylinder. The handwheel is operative only when required, at which time a bypass valve opens to equalize the pressures.

Operating pressures are selected as required for positioning the equipment to which the cylinder is connected. Use of the technique described under "Springless Diaphragm Actuator" allows the use of elevated pressures to advantage.

Actuators using electrical power will be discussed in the next article.

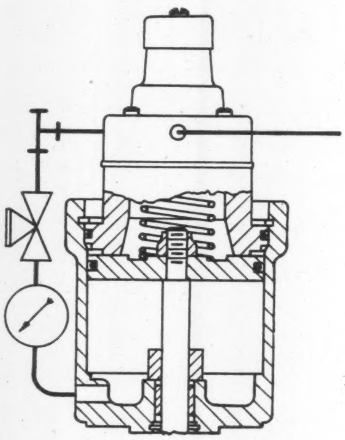


Fig. 6-24. Cylinder actuator uses positioner to adapt unit to pneumatic controller.

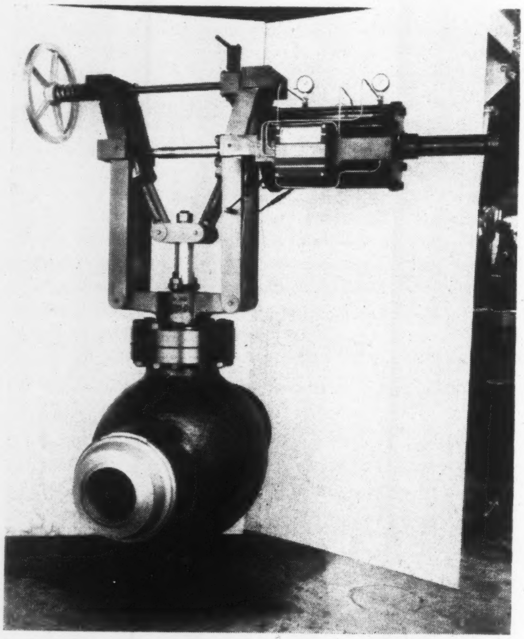


Fig. 6-25. Horizontal action of cylinder is converted into vertical stem motion via toggle arms, which can be moved also by the handwheel.

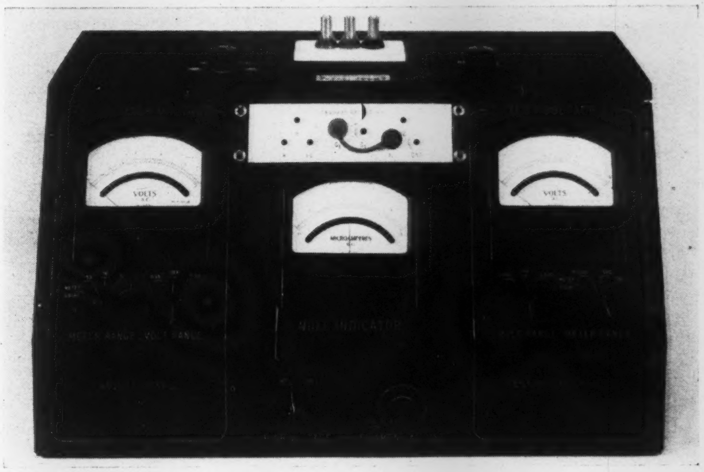


Fig. 1. Slideback electrometer can be used for measurement of high-resistance resistors, capacitor leakage, etc.

Slideback Electrometer

An instrument is described for measuring resistances between 10^{10} and 10^{15} ohms. The instrument is in part a slideback voltmeter employing an electrometer tetrode.

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STUDY of the electrical characteristics of insulating materials is of growing importance. Low-leakage resistance paths in terminal boards, in laminates which bear etched wiring circuits, and in potted assemblies can seriously alter operation of electronic systems. It was the object of the work reported here to design a high-resistance measuring instrument which would aid in the evaluation of high-resistance materials.

A series-resistance method has been discussed by Norman[1] and is an ougrowth of a series-capacitance method employed by Race[2]. Their instruments employ a high-impedance null detector and a slideback compensating voltage.

The series-resistance method is shown in Fig. 4, which is a simplified form of Norman's circuit. Test voltage V_T, causes a current (i) to flow through the circuit in which R_X is the resistance under test and R_S is a known standard resistance. The slideback voltage V_S must equal iR_S for the null detector to read zero. This method of measurement has several advantages: (1) the test voltage is the exact voltage which appears across the unknown, (2) the slideback voltage can be read on a high-accuracy D'Arsonval-type indicator, and (3) with guard-ring techniques the guard and guarded electrodes are at the same potential at the time of measurement.

Description of Instrument

Fig. 5 is a schematic drawing of the instrument described. The instrument is shown in Fig. 1.

A. *Electrometer Tube*—The tube, V1, is a 5800/VX41A subminiature electrometer tetrode. This tube has extremely high leakage resistance (greater than 10^{15} ohms) between the control grid and the other electrodes, and extremely low grid current (nominally 3×10^{-15} ampere). Electrometer tubes, including the 5800/VX41A, have been discussed by Victoreen[3].

B. *Voltage Supplies*—The voltages for the electrometer tube are supplied by six 1½-volt batteries (BT1) and dropping resistors.

The test voltage (10 to 500 volts) is supplied by two 300-volt batteries (BT2) and a potentiometer. The two batteries can be connected in series or in parallel. A safety resistor of 1 megohm is included between the test-voltage supply and the high-voltage terminal to eliminate shock to the operator if the terminal is accidentally touched and to protect the supply batteries in event of accidental shorting or a breakdown of the item under test. This safety resistor is small compared to any resistance being measured in the circuit and can be neglected in the calculations.

The slideback voltage is supplied by a 30-volt battery (BT3) and a potentiometer arrangement.

C. *Indicators*—The instrument contains three indicators. The slideback-voltage voltmeter (M3) measures the magnitude of the slideback voltage. This meter has ranges of 1, 5, 10, and 50 volts full scale, plus a "meter-short" position for zeroing. It has a mirrored scale, 10,000-ohm-per-volt 1-percent movement, and a resistance of 1000 ohms.

The second indicator (M2) is a 15-0-15-microampere mirrored-scale galvanometer for null detection. R2 is for balancing plate current and bucking current when the control grid of V1 is grounded.

The third indicator (M1), identical to that of M3, has ranges of 100 and 500 volts full scale. This "test-voltage voltmeter" measures the magnitude of the test voltage and has a "Fil.10" position for establishing the proper bias voltage, accelerator voltage, and plate voltage for the tube.

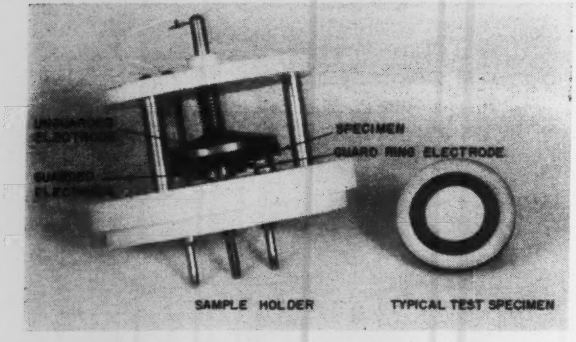

Fig. 2. Sample holder for measuring volume and surface resistances of plastic samples.

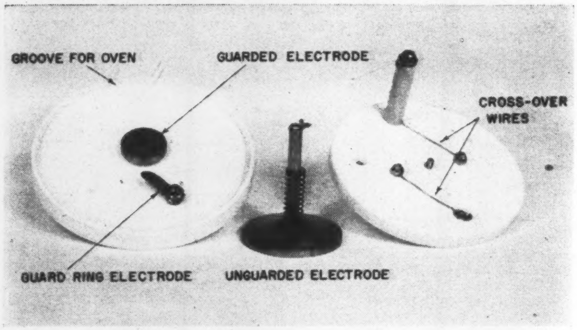

Fig. 3. Exploded view of sample holder, showing elements and construction.

D. *Grid Grounding Switch*—Switch 3 (bottom left in Fig. 5) will either ground or unground the input of the electrometer. It controls the current applied to a high-resistance thermally operated switch (K1). The resistance of this switch when open is a minimum of 10^{15} ohms.

E. *Standard Resistors and Shield*—The standard resistors are a carbon-film type, vacuum sealed in glass envelopes, and specially treated for stability under high humidity conditions. The values are approximately 10^8, 10^9, 10^{10}, 10^{11}, and 10^{12} ohms. These resistors were measured to an accuracy of 0.2 percent by the National Bureau of Standards. Experience with this type of resistor has shown that fluctuations with time may be as great as 1.0 percent.

The standard resistors are mounted on a polytetrafluoroethylene block containing banana jacks which allow easy selection and connection to the grid circuit of the desired standard resistor. The three terminals on the top of the instrument are also mounted in a polytetrafluoroethylene block.

The need for adequate shielding when measuring very high resistances has been met by a conducting shield which fits over the standard resistor block. The material under test is also shielded.

F. *Sample Holder*—Three plug-in terminals for a sample holder can be seen on top of the instrument. A sample holder (Fig. 2) was designed for use when employing guard-ring techniques for the measurement of dielectric materials. When the holder is plugged in one way the circuit is arranged for the measurement of volume resistance; on rotating the holder 180° and plugging it in that way, the circuit is arranged for surface resistance measurements.

The sample holder bears a groove designed to accept an oven which will fit around the sample holder. This oven, when used with a heat exchanger, makes it possible to raise or lower the temperature at which the sample is to be measured.

Techniques

There are two methods of measurement which can be used with this instrument. One employs conventional slideback potentiometer technique. The other is a direct-reading technique in which no slideback voltage is employed and the null indicator is calibrated to read directly in volts. The slideback method should provide better accuracy because this technique is independent of tube characteristics. Experience has shown, however, that the grid-voltage vs plate-current characteristics for the tube used are reproducible even when measured several months apart and, for some applications, the direct-reading approach is more convenient.

Measurement of Resistance of Resistors

Using the test-voltage switch and test-voltage adjustment knob, and with the test-voltage meter on the proper range, the desired test voltage is set. A standard resistor of approximately one-hundredth the value of the resistor being measured is inserted into the circuit with a jumper from G_1 to the desired resistor. The unknown resistor is connected between the high and low terminals. With the grid still shorted to ground, the test voltage is switched on, the grid is ungrounded so that a voltage appears across the standard resistor, and a slideback potential is introduced such that the null indicator is just returned to zero.

The resistance of the unknown resistor is calculated from:

$$R_X = R_S(V_T/V_S)$$

where R_X = resistance of resistor under test; V_T = test voltage; V_S = slideback voltage; R_S = resistance of standard resistor.

The null indicator can be calibrated in percent from nominal, and used for sorting.

Leakage Resistance of Insulating Materials

The two points between which the leakage resistance is to be measured are connected to the high and low terminals and measured like a resistor. Reference is made to ASTM Method No. D257-52T[4] for electrode configurations. As the apparent leakage resistances for many materials show a considerable change with time of electrification, the resistance value is usually specified as the resistance after 1 minute (or some other time interval) of electrification.

Volume Resistance and Surface Resistance

Where it is desired to separate the volume and surface leakage currents of a material, the three-electrode configuration of Fig. 4 of ASTM Method No. D257-52T[4] is applied to the specimen. Details of the electrodes and errors introduced with various configurations have been described by Amey and Hamburger[5]. The approximate equations for calculating volume and surface re-

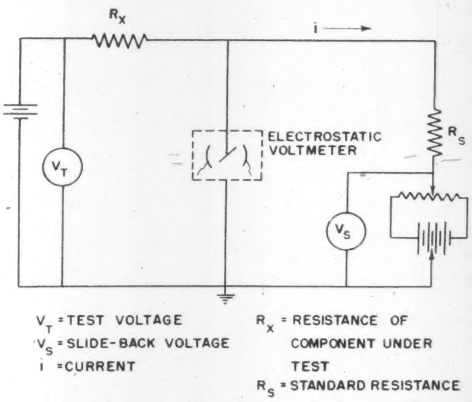
R_X
i →
ELECTROSTATIC VOLTMETER
R_S
V_T
V_S
V_T = TEST VOLTAGE
V_S = SLIDE-BACK VOLTAGE
i = CURRENT
R_X = RESISTANCE OF COMPONENT UNDER TEST
R_S = STANDARD RESISTANCE

Fig. 4. Principle of slideback method for resistance measurement. Voltmeter is nulled when slideback voltage is nade to equal voltage drop across R_S; R_X then equals $R_S)(V_T/V_S)$.

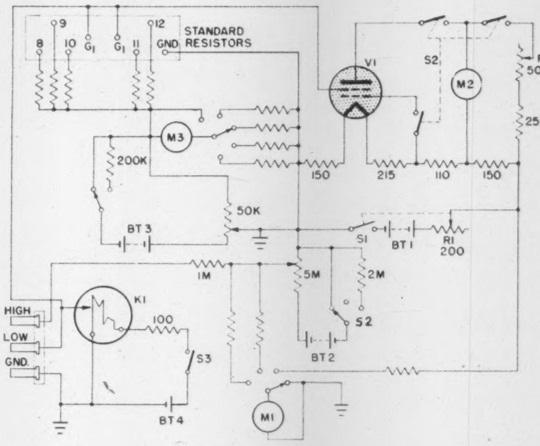

Fig. 5. Schematic of slideback electrometer. V1 is electrometer tetrode; M2 is null detector; BT2 supplies test voltage, which is read on M1; BT3 supplies slideback voltage, which is read on M3.

sistivities from volume and surface resistances are given in ASTM Method No. D257-52T[4].

Leakage Resistance of Capacitors

To measure the leakage resistance of capacitors it is nost convenient to use the rate-of-charge method[6]. This echnique requires that the electrometer be used as a lirect-reading instrument.

The desired test voltage is set as described previously, ut all standard resistors are disconnected; hence, when he grid is ungrounded, the electrometer grid is shunted nly by the input capacity of the electrometer. This capacity will begin to charge and the voltage on it can be determined from the deflection of the null detector by referring o a curve of input voltage vs null-indicator current. By neasuring the length of time required to charge the input apacity to a certain voltage, the leakage resistance of the apacitor under test can be computed by the following quation, the derivation of which is given by Tucker and Breskend[6]:

$$R_X = (V_o t)/(V_i)(C_i + C_X)$$

vhere R_X = leakage resistance of the capacitor under est; V_o = test voltage; V_i = standard-resistor voltage btained from calibration curve; C_X = capacity of the apacitor being measured; C_i = input capacity of electrometer. This can usually be ignored compared to C_X ince it is less than 10 micromicrofarads.

If the megohm-microfarad product of the capacitor uner test is less than 10,000, C_i should be increased by utting high-leakage-resistance capacitors in parallel with $_i$ until $(R_X)(C_i + C_X)$ equals approximately 10,000. f this is not done, the needle of the null detector will veep across scale too rapidly to be timed accurately.

Accuracy and Precision

When employing slideback technique, the calculated sistance is the quotient of two meter readings times the alue of a known standard resistance; hence the *accuracy* epends on the accuracy of these three items. The *preci- on* is determined from the ability to read the meters and t the null. Each indicator has a 1-percent movement nd 1-percent resistors for the various ranges. Further- ore, these meters have been calibrated for their most used scales with a ½-percent secondary standard. The null indicator can be set to 0.1 microampere, which is equivalent to less than 0.005 volt. The standard high-megohm resistors are expected to remain within 1 percent of the initially measured value.

Unless meter readings are made in the lower third of the meter scales, an accuracy of plus or minus 2 percent is usually obtained.

Discussion

When the 10^{12}-ohm standard resistor is used, it is found that an unwanted time-constant of several seconds is introduced by wiring, tube, and sample capacities. This time constant usually makes slideback operation impossible where measurement must be made within one minute. In these cases an initial slideback voltage is set and the direct reading method is used to add or subtract from this value by using the calibration curve.

An auxiliary device could be designed to apply the test voltage and unground the grid as each resistor is placed across the test leads, thus speeding up the operation and adapting the instrument for industrial sorting of high-resistance resistors.

Acknowledgment

The authors wish to acknowledge the assistance of Mr. M. Weber in the design of the sample holder, and of Mr. E. Zugby and Mrs. Ruth Brown in the construction of the finished instrument.

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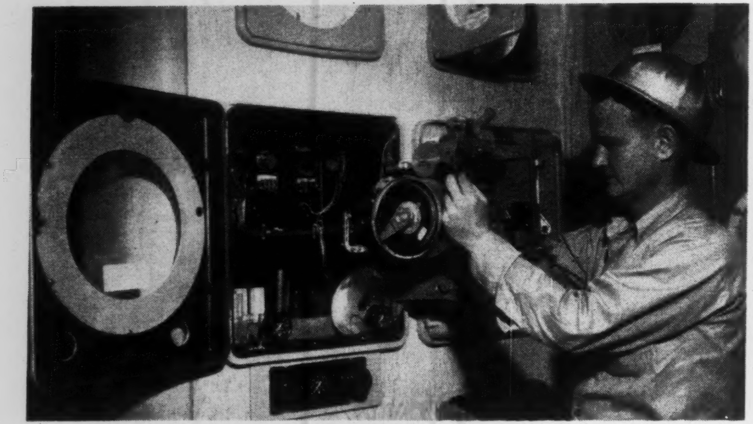
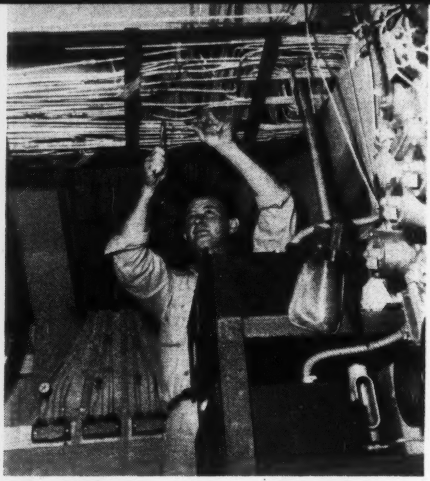


1. Instrument Repairman J. B. (Tiger) Daniels keeps this temperature recorder-controller in good shape.

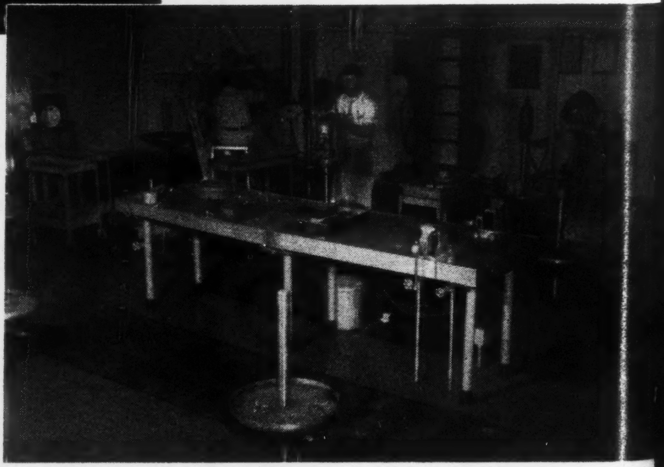


2. Tubing, tubing, tubing. Here Tiger revamps the air lines to a new piece of equipment.

Process ⇄ Instrumentation

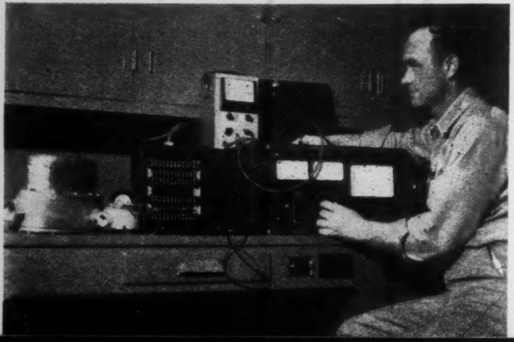
ON page 1097 of this issue you met Mac Fortney. Here are a few typical instrument activities at his plant—the Baytown, Texas plant of Humble Oil & Refining Co.

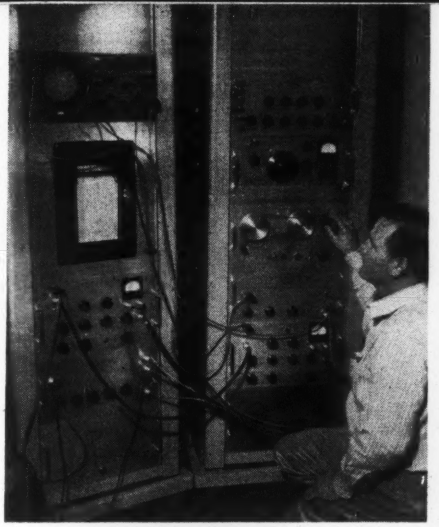
3. R. M. Pickering (left) and W. A. Cook like the special gage holder with spin-type connector and inclined mounting for easy access to gage. "Makes gage repair almost a pleasure."



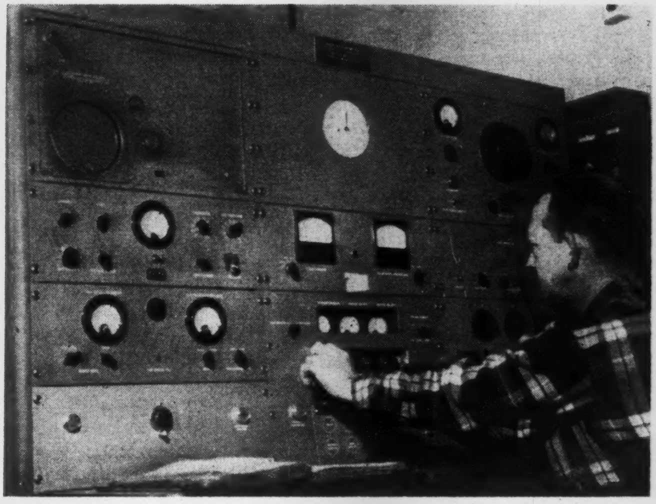
4. Orifice-meter section of the meter and gage room. Features include stainless-steel tables, smooth waxed floor (no mercury accumulation here), temperature controlled environment, suction vents below breathing level. Water manometer in background features cold-cathode-tube lighting, periscopes, and 200-inch height.

5. J. E. Matthews (Technician) calibrates a receiver for remote tank gages.

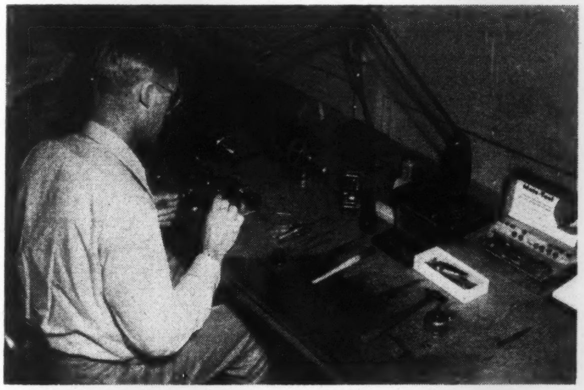




6. R. R. Connor (Technician) adjusts the nuclear-magnetic-resonance spectrometer in the Physical Measurements Lab., which also has a Spectro-Sadic, several mass spectrometers, x-ray and infrared spectrometers, flame photometers, etc.



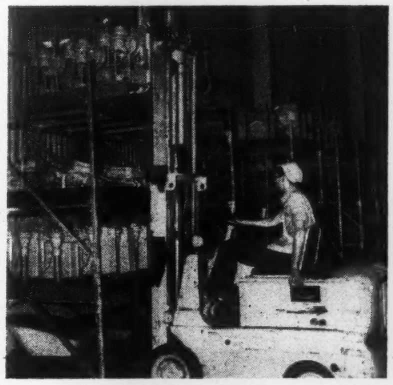
7. Technician T. P. (Tommy) Gorman checks out a mass spectrometer.



8. H. A. (Swede) Ehrlund (horologist) at work in the clock room.

9. Instrument Repairmen W. B. Horton (left) and B. H. Jones service a special-built valve for handling hot, weak sulphuric acid on a special valve-holding jig.

10. Technician Obe Therman uses thermocouple-checking equipment, comprising multibridge, light-beam galvanometer, Type-K potentiometer, oil bath with stirrer, and Variac-controlled muffle furnace.



11. Special upright holders for flowmeters double shelf capacity.

12. W. H. (Mac) Fortney (previously Instrument Foreman and now general foreman of Refinery Central Mechanical Shop) receives Certificate of Merit from Safety Director L. J. Weiler (right) for 10 years and over 2 million man-hours of instrument-department operation without a disabling accident.

ELECTRONIC

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Instruments & Automation

and

CHARLES F. KEZER
Key Electric Corp.

IONIZATION GAGE USES 3C24 TRIODE

The triode ionization gage is, by far, the most commonly used vacuum gage for pressures lower than 10^{-4} mm of Hg. A useful range of from 10^{-3} to 10^{-9} mm of Hg can be covered with a single instrument. The tube is similar to an ordinary triode used in an amplifier.

A conventional 3C24 power triode is converted into a rugged ionization vacuum gage by this circuit (and, of course, by attaching a graded seal so that the tube can be connected into a vacuum system).

In an ionization vacuum gage a high positive voltage is placed on the grid, while the plate is operated at a low negative potential relative to the filament. Hence the grid collects all the electrons emitted from the filament. Tubes with cathodes are not usually used because the surface tends to become poisoned by destructive action of certain gases. Another departure from convention is that the filament is operated in a temperature-limited condition rather than space-charge limited. The conventional cloud of electrons (space charge) is not allowed to form just off the surface of the filament. This feature necessitates operating the filament at a reduced voltage so that the emission can be temperature-limited. Tube characteristics are quite different under temperature- and space-charge-limited conditions.

Electrons boiled off from the hot filament are attracted to the positive grid of the ionization tube. As the grid is a helix of wire, a high percentage of the electrons will miss the grid on their first pass. The electrons missing the grid will be thrown towards the plate by their momentum. However, the electrons are repelled because of the negative operating potential of the plate. Again the electrons attempt to collide with the grid; some electrons make several of these grid-to-plate-to-grid oscillations before colliding with the grid. Note that the plate is negative with respect to the filament in the circuit shown because the plate is returned to a ground potential whereas the filament circuit is returned to a positive potential via a divider (10 K and 2.5 K to B+), which provides up to 43 v, depending on the adjustment of the 2.5 K resistor.

If gas molecules from the vacuum system are in the tube, the electrons ionize a few of the molecules during flight. As soon as a positive ion is formed, it is attracted to the negative plate. If one can detect the positive-ion plate current, a measure of the system pressure is available because the number of ions formed during collisions of the molecules and electrons is proportional to the pressure; the plate current is a linear function of the pressure for a constant value of electron emission from the filament.

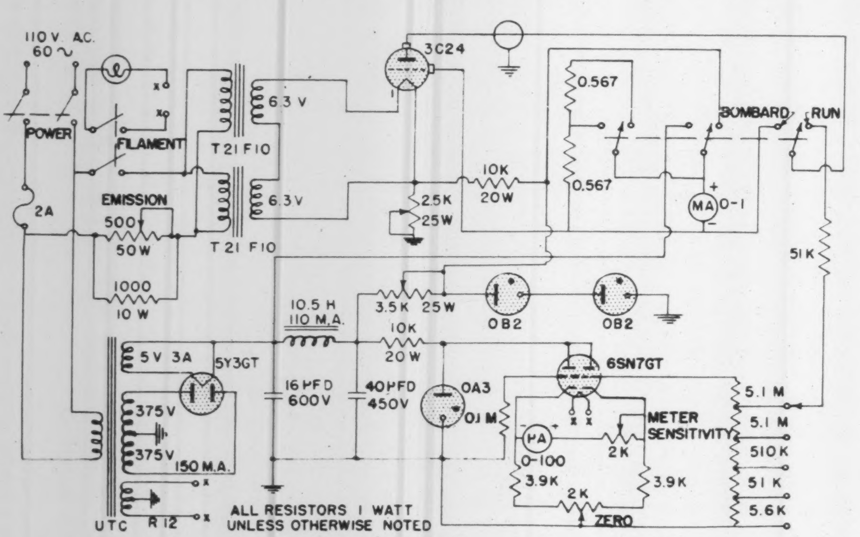
The conventional full-wave-rectified high-voltage supply provides positive potentials for the grid and filament of the 3C24 tube; voltage regulator tubes are used to maintain a constant 216-v supply for the grid. Two six-volt filament transformers in series comprise the 12-v filament supply for the 3C24. A series rheostat in the transformer primary permits the electron emission from the filament to be varied.

Connection to the plate is made with a shielded cable to minimize stray pick-up. The ion current (from the plate) flows through a series of resistors producing a voltage drop proportional to the pressure.

A 6SN7 tube is used in the indicator circuit, which is a conventional vacuum-tube voltmeter. When no ion current flows, the zero-adjust potentiometer is set to balance the 6SN7 cathode potentials. Voltage developed by the ion current causes one cathode potential to vary, and the signal is detected by a 100-microampere indicator. A switching arrangement provides different VTVM sensitivities. The meter-sensitivity rheostat can be used to adjust the meter to a particular value when the ionization-gage tube is calibrated against a McLeod gage or other reference standard.

The resistors across the 0-1 ma meter (0.567 ohm each) are for changing the meter sensitivity. In the BOMBARD position (used for degassing the tube), the meter has a sensitivity of 0-100 ma; in the RUN position the sensitivity is increased to 0-50 ma.

The B+ voltage to the 3C24 grid is 216 volts since the tap comes from the voltage regulator tubes. During bombardment of the plate (3C24), the voltage regulator tubes go out because of the excessive current drawn through the current limiting resistor (3.5 K); however, regulated voltage is not needed during bombardment whereas nor-



CIRCUITRY

The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

mal operation requires constant grid potential.

B Supply: At output of filters of the B+ supply, the voltage is approx. 450 volts. The total current drawn from the B+ supply is approx. 90 ma. The 3C24 tube draws up to 50 ma at 216 volts during normal operation; the exact value depends on the grid current at which the tube is calibrated.

Maximum sensitivity of VTVM: approx. 0.1 v.

Source: Loren E. Bollinger, Research Associate, Rocket Laboratory, Ohio State University, Columbus 10, Ohio; also *Instruments & Automation*, Sept., 1955, pages 1507-09.

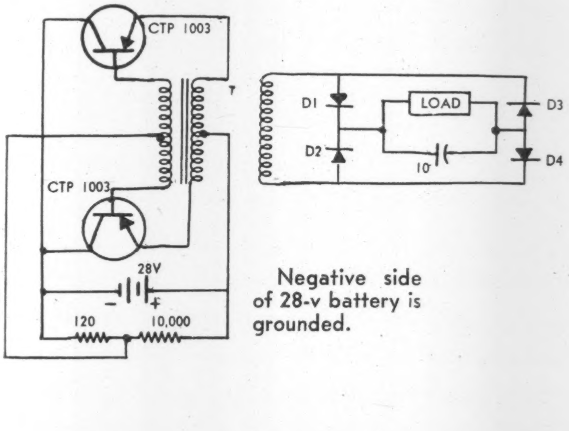
TRANSISTORIZED DC-to-DC POWER CONVERTER

This circuit is designed to convert low battery voltages to other DC voltages with good efficiency, replacing conventional dynamotors and vibrator-type power supplies. It is called the "Transverta" by its manufacturer.

The push-pull transistor oscillator "chops" the battery voltage, providing a nearly square output waveform. Frequency is determined by transformer design and battery voltage. An output winding provides the desired voltage step-up or step-down ratio. Germanium or silicon junction diodes are used as power rectifiers. As the square-wave fundamental frequency can be as high as several kilocycles, a shunt capacitor (10 uf, 250 v) is usually all that is needed to provide adequate filtering.

Only one transistor conducts at a time; the non-conducting transistor is held cutoff by the voltage developed across the feedback winding (connected to transistor bases).

During a half-cycle of operation, most of the battery voltage is developed across the corresponding half of the input winding, with little drop across the conducting transistor. The flux in the transformer core rises linearly during this time, to maintain constant voltage across the input winding. When the transformer core reaches saturation flux density, a transient occurs, and current is switched to the previously cutoff transistor.



Negative side of 28-v battery is grounded.

Current flows in this transistor until the core reaches saturation in the reverse direction, when the transistors again switch. Frequency of operation is directly proportional to input dc voltage, and inversely proportional to transformer core area, input winding turns, and saturation flux density. Transformer is made of square-loop-hysteresis material.

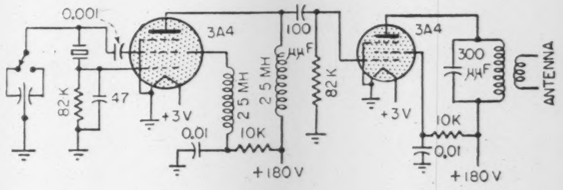
In the circuit shown, type IN346 diodes are used and operation is given for following transformer design: Core—Ferroxcube 206F440; Emitter Winding—100 T, C.T., #26; Base Winding—120 T, C.T., #32; Output Winding—385 T, #36.

Square Wave Frequency: 4500 cps
Input Voltage: 28.0 v
Input Current: 405 ma
Output Voltage: 145 v
Output Current: 55 ma
Efficiency: 70.5%

Source: Clevite Transistor Products, 241-257 Crescent St., Waltham, Mass.

FREQUENCY-SHIFT ALTITUDE TELEMETER

This two-tube battery-powered transmitter is used in high-altitude radiation tests. One 3A4 tube is used as an electron-coupled crystal (1.75 Mc) oscillator, driving a second 3A4 power amplifier.



Altitude is sensed by an aneroid bellows, which drives the movable plate of a variable capacitor. This plate moves laterally between two fixed plates. Thus, as altitude increases, capacitance from the movable plate to one fixed plate increases, while capacitance to the other decreases. These two capacitances are alternately switched across the crystal by a motor-driven switch. Switching occurs at approximately 30-second intervals, and the frequency difference obtained is used as a measure of altitude.

At the ground receiving station, the received signal is mixed with a local oscillator operating at the transmitter frequency, and the frequency difference is measured with a frequency meter and recorded. Frequency shift is a nearly-linear function of altitude up to 80,000 feet.

Power Output: 1.25 watts.
Carrier Frequency: 1.75 Mc.

Frequency Shift: 500 cps for altitude change of 0-100,000 feet; 70 cps per 10,000-foot change in altitude over linear range from 10,000 to 80,000 ft altitude.

Power supply: 3 v dc at 400 ma for filaments; 180 v dc at 15 ma (est.) plate supply.

Source: Aeronautical Research Div., General Mills, Minneapolis, Minn.; also *Electronics,* May 1954.

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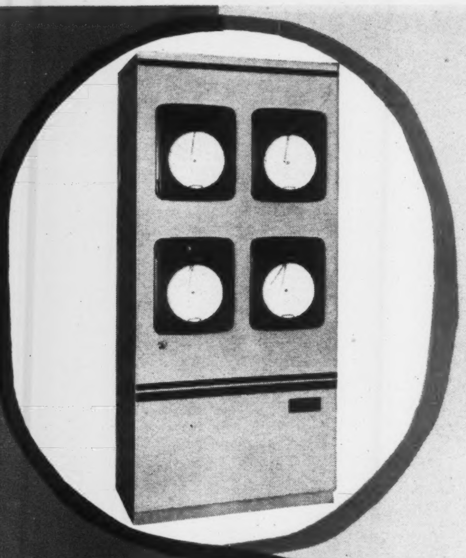

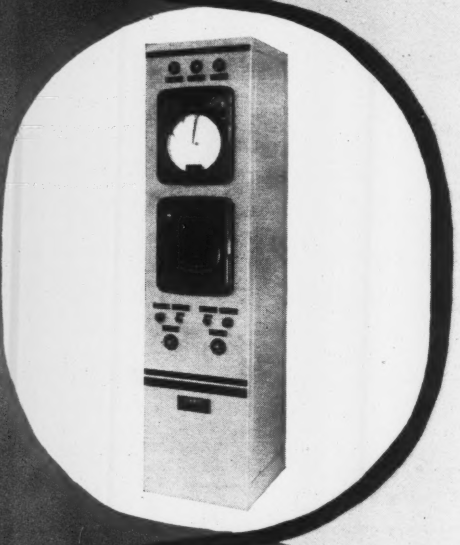

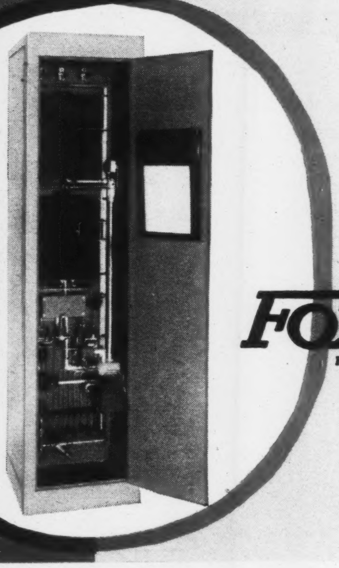

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Process Applications of ANALYTICAL INSTRUMENTS

This résumé of the implications and applications of analytical instruments in the process industries covers the reasons why analytical instruments should be used (legal, safety, and efficiency) and the principles of operation of infrared, ultraviolet, mass-spectrometer, refractometer, magnetic-susceptibility, thermal-conductivity, and electroconductivity techniques.

HERBERT SIMON
The Fluor Corporation, Ltd.

ANALYTICAL INSTRUMENTS must be used in the process industries in order to utilize many modern processes economically; they can perform tasks not possible by normal measurement and control of the process variables of temperature, pressure, flow and level. This article discusses the most important reasons for the use of these new tools, and explains briefly their basic principles of operation.

I. CONTINUOUS MONITORING ANALYTICAL INSTRUMENTS

Continuous monitoring analytical instruments may be required for any of the following reasons:

A. Legal Requirements

1. *Waste Disposal—Air and Stream Pollution*

The universal danger of smog, smaze or what have you, has given impetus to use of air monitoring equipment. Many companies have found that this expenditure has saved them much time and money in providing compliance with local ordinances. Hydrogen sulfide and sulfur dioxide, common air pollutants, can be measured as a total by pyrolyzing the H_2S to SO_2, dissolving the sample in distilled water, and measuring with an *electroconductivity instrument.*

If the sulfur had all been in the form of hydrogen sulfide (as would be the case in oil-refinery sour-water-stripper off-gas) *infrared, oxidation-reduction,* or *chemical colorimetric* techniques could be used.

Pollution of air with hydrocarbons, particularly unsaturated olefins, has been designated as contributory to smog incidence; there are several *infrared instruments* in this service with ranges as low as 3 ppm.

Oxides of nitrogen are considered to contribute to the chemical synthesis of smog. Nitric-acid plants emit nitric oxide and nitrogen dioxide in the vent stack gas. *Infrared equipment* has been used to monitor this stream. A maximum concentration of 0.2% at the stack is usually maintained by operators of this type of plant.

July **Meeting:** *Field trip to Brea Chemicals, Fullerton, Calif., Thursday, July* 19, 7:30 *p.m. Each person make own arrangements for dinner.*

Prepared for the Los Angeles Harbor Junior College and Southern California Meter Association Instrument Short Course. January 26 and 27, 1956, Wilmington, Calif.

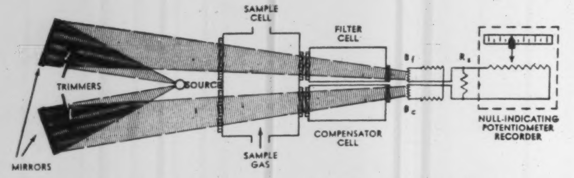


Fig. 1. Negative filter-type infrared filter photometer. Analyzed constituent gas is placed in filter cell. Bolometer signal is difference before and after absorption in filter cell.

2. *Public Safety and Insurance*

Public safety and insurance requirements often coincide. Most of us are familiar with the requirements of the National Fire Underwriters' Code, API and ASME Codes which have contributed greatly to public safety and well being. However, there are still other types of accidents which, it is hoped, can be prevented by the use of monitoring instruments.

It is the practice of at least one major oil company to use a *combustible alarm* and eventual shutdown in their control houses in order to have a general-purpose electrical classification for the area instead of a hazardous classification with its resultant higher cost construction.

In addition to monitoring the atmosphere, there are many hazardous processes which have to be watched carefully. Applications which require the use of inert gas for blanketing and purging (as are required in many hydrocarbon reforming processes) require *combustible monitoring* to prevent serious accidents. A recent development is the automatic control by a combustible instrument of the fuel gas-to-air ratio used in the inert-gas generator.

Air plants have been known to blow up by acetylene and/or hydrocarbons being drawn into the air intake and being concentrated in the pure oxygen product up to the explosive limit. The concentrations are too low to be detected by combustible instruments; specially sensitized *infrared instruments* are now being tried.

3. *Personnel Safety*

There are some compounds which are toxic to humans at concentrations too low to support combustion. In closed areas, *electroconductivity* instruments are in service monitoring chlorine and nitric oxide. Most large cleaning plants monitor carbon tetrachloride by electroconductivity. A brewery uses *infrared* to detect ethylene glycol in its refrigeration plant. In England a supplier of diesel oil has been subject to court action due to the death of six people who inhaled engine exhaust fumes containing vanadium. This could have been prevented by monitoring the product with a *flame photometer*.

B. Contaminants

1. *Damage to Equipment due to Corrosion and Metallic Breakdown*

Fabrication of equipment from stainless steel may be three to ten times the cost of similar equipment made of carbon steel. Therefore, it should not be difficult to justify the use of a monitoring instrument so that carbon steel equipment can be used without trouble; hydrogen sulfide is a prime source of corrosion in most refineries.

The vanadium found in diesel oil in England has been found in fuel oil in this country. When the fuel oil is burned, vanadium oxide is formed, which will cause deterioration of heater tubes in a short time. Sodium compounds in sour fuel oil will form sodium sulfate with similar damage to heater tubes.

2. *Poisoning of Catalysts*

This is an extremely large field with many examples from which to draw. With the emergence of petroleum reforming processes using platinum catalyst, the amount of sulfur- and nitrogen-bearing compounds, particularly in the recycle gas, has been of great importance. The sulfur could be in the form of hydrogen sulfide, carbon disulfide, carbonyl sulfide, mercaptan or thiophene. The nitrogen could be in the form of amines or pyridine. The total amount of both of these groups can be determined by pyrolyzing the sample, dissolving in distilled water and measuring the *electroconductivity*. An interesting way of measuring just the total amount of sulfur compounds is the methylene blue method using a flow *colorimeter*.

Sulfur compounds are harmful also to silver catalyst used in one-step production of ethylene oxide from ethylene and air, and are harmful also to nickel catalyst used in conversion of carbon monoxide to make hydrogen for ammonia synthesis. Carbon monoxide poisons the synthesis catalyst itself.

3. *Contamination and Corrosion Products*

This category often involves health and sometimes should be under the legal requirements of the Pure Food and Drug Laws. *Flame photometry* can determine copper and iron in sugar syrup or milk, or iron in urea if it is to be used for cattle feed. Most contaminants in edible products seem to be metals or metallic compounds; the *flame photometer* or *x-ray spectrometer* seems to hold the most promise, depending on the atomic weight of the metal.

C. Process Control

1. *Process Specification Requirement*

A plant often must be designed to operate with higher design capacity to insure meeting product specifications. During World War II, the Government specification for butadiene was 98.5% purity with other specifications for the remaining 1.5%. In order to insure the 98.5% purity, the purification plant was designed for 99.0%. This additional capacity, absorbing and desorbing equipment, and additional chemical extractant, cuprous ammonium acetate or furfural, amounted to about $20,000 on a 200-ton unit. With an investment in an *ultraviolet* instrument with an accuracy of ±0.1%, consideration could be given to reducing this overdesign.

There was a similar occurrence in a plant that sold isobutane to an alkylation plant. In this instance, ordinary (temperature, pressure, etc.,) control had an accuracy of ±2%, which forced the plant to operate at 2% higher than specifications called for in the contract. *Infrared* techniques reduced this margin to ±0.2%.

2. *Optimum Yield of Product and Efficiency of Equipment*

A major problem in the synthesis of ammonia has been the build-up of argon. Argon enters the system with air to the air plant. The argon is inert, but if a constant pressure in the process is to be maintained, the partial pressure of the nitrogen and hydrogen must be reduced with a resultant lowering of conversion. The system must be blown down in much the same manner that a boiler must be blown down. This vent stream contains hydrogen, nitrogen and ammonia—all money products. In the past, operators have reduced the pressure to a low limit in order to give a time interval until the next blowdown is necessary. This is an extremely wasteful procedure. To solve this problem, many concerns now use instruments based on *radiological* and *mass spectrometer* principles. A pressure controller resets the analytical instrument to give optimum automatic operation.

II. PRINCIPLES OF OPERATION

Analytical principles which can be used for the continuous analysis of multi-component streams include infrared and ultraviolet absorption, mass spectroscopy, magnetic susceptibility, thermal conductivity, and refractive index.

A. Infrared and Ultraviolet

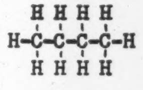
Practically every pure compound—irrespective of its state of aggregation (gas, liquid or solid), pressure, and temperature—shows spectral activity somewhere in the infrared region, somewhere in the visible ultraviolet region, or somewhere in the microwave region. Molecules without dipole moment (those having two identical atoms in the molecule) form exceptions to this rule. To the knowledge of the author, continuous process monitoring equipment using radiation in the microwave region is not presently on the market, and will not be discussed.

Perhaps the most useful in terms of number of applications is equipment using the infrared principle. Long a laboratory tool, it has been only since 1950 that reliable continuous instruments have been available, although applications are known back to 1938.

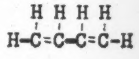
Infrared rays may or may not be absorbed by a compound—depending on the atomic weight, the chemical bond, and also the physical arrangement of the atoms within the molecule. Atoms within a molecule vibrate at a specific frequency at a fixed energy level (Temperature) and pressure. Physically, the atoms could be likened to a ball or balls at the end of perfectly elastic rubber bands. If the infrared ray is at the same frequency as the atomic vibrations, it will be absorbed. As with the absorption of another type of energy—heat—the temperature of the gas will increase (as may be measured by a thermopile or bolometer) or the pressure will increase (as may be measured by the deflection of one plate of an electrical capacitor). In the event of an interfering secondary frequency of another compound, the temperature or pressure is "subtracted" by 1, 2, or 3 filtering cells. This is called a non-dispersive-type analyzer, which is the type most commonly in use.

When investigating the suitability of infrared to a specific problem, the chemical formula of the compound must be considered. As the range of the infrared-wave spectra used is generally 2.5 to 20 microns, the molecule to be isolated must have two or more different kinds of atoms. Carbon monoxide (CO) has carbon and oxygen; therefore, it may be accurately measured by infrared. The nitrogen molecule (N_2) cannot, as the vibrational frequency is not great enough.

Consider whether the molecule has a marked vibrational frequency as determined by the three factors previously listed—atomic weight, chemical bond, or arrangement of atoms within the molecule. Butadiene has atoms of the same weight as butane, but has a conjugate double-bond system which means there is much more "dumb-bell" motion to and from the adjacent carbons.

Butane 

$$\begin{array}{c} H\ H\ H\ H \\ H{-}C{-}C{-}C{-}C{-}H \\ H\ H\ H\ H \end{array}$$

Butadiene 

$$\begin{array}{c} H\ \ H\ \ H\ \ H \\ H{-}C{=}C{-}C{=}C{-}H \end{array}$$

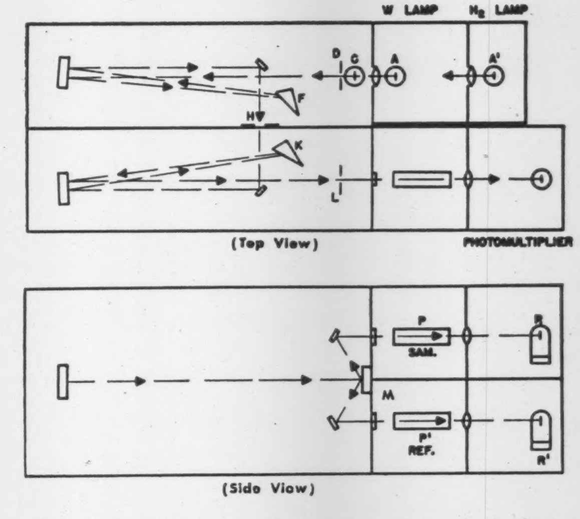


Fig. 2. In this spectrophotometer of Applied Physics Corp., monochromatic radiation from hydrogen arc (A') or tungsten lamp (A) passes through quartz prisms (F and K) selected for ultraviolet transmission, then through sample and reference cell, and then strikes matched phototubes in automatic bridge circuit.

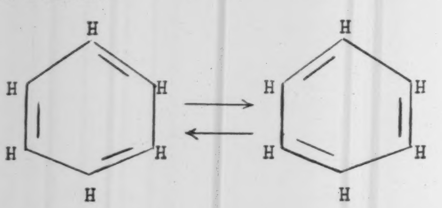
Now, consider only the end groups. The $\overset{H}{\underset{H}{H\text{-}C\text{-}}}$ groups on butane vibrate and rotate with respect to the adjacent carbon within the limits of a cone, as with a ball on the end of a string. However, the double bond of the $\overset{H}{H\text{-}C{=}}$group may only move in a plane with respect to the adjacent carbon as prescribed by the double bonds.

Measurement of butadiene has been made using equipment similar to infrared, but using a light source in the ultraviolet range. However, there is a great difference between infrared and ultraviolet radiation with respect to what happens within the molecule of the substance being analyzed.

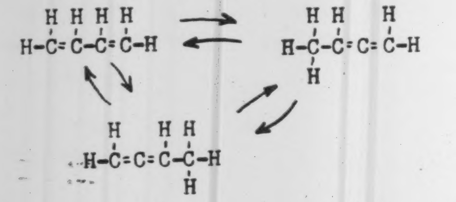
In the study of the reaction of the molecule to infrared, instead of imagining the molecule as a nuclear framework stabilized by an electronic "cloud," the picture of neutral atoms kept together by elastic forces must be used. Infrared radiation enters the molecule, displacing the atoms as "the balls on the rubber bands."

It is of interest that the molecule does not absorb the radiation as a sponge absorbs water—that is, there is no saturation point at which the energy passes thru the sample unchanged. This is due to the *Raman effect.* If any substance—gaseous, liquid, or even solid—is exposed to radiation of a definite frequency, then some of the radiation is scattered at right angles. The frequencies of the scattered radiation differ from that of the incident radiation and are characteristic of the substance under examination. The accepted mechanism of the Raman effect is that a molecule absorbs the incident radiation and is thereby raised to a higher level; it then emits the Raman scattered radiation and falls to a level usually between the initial and excited states.

The type of molecule ordinarily analyzed by ultraviolet radiation often has a conjugate double-bond system. The molecule under ultraviolet radiation actually has an electron transference. This effect is similar to the Kekule resonance of the benzene molecule where there is a transference of electrons from carbon to carbon atom to obtain as a point state, the following configuration for benzene:



This is an equilibrium state, not needing ultraviolet energy. Butadiene has been successfully analyzed for by ultraviolet with the following transference:



This reaction to ultraviolet radiation makes its analysis much more selective in the presence of other C-4s than infrared, which would have to detect a much smaller energy difference as described previously in the discussion of butane vs. butadiene.

B. Mass Spectroscopy

All substances have weight or mass with a characteristic arrangement of atoms within its molecule, and, therefore, may be measured by the mass spectrometer. The mass spec often is used when other equipment (generally less expensive) cannot do the job. Infrared, ultraviolet, thermal conductivity and other techniques cannot be used for nitrogen, helium, argon, krypton, etc.; the mass principle must be used. (It is often true that where a mass spec must be purchased, it is made adaptable to analyzing for a large number of components on a time sequence or scanning basis.) The mass spec generally will do the job assuming the concentration is not too low. One failing of the mass spec is that it cannot distinguish between isotopes, as for example: n-butane and iso-butane.

When the molecule is bombarded by an electron beam, it breaks up in a manner which is characteristic of the original arrangement of the atoms within the molecule. These molecular fragments are ions, and have an electrical charge. Therefore, they move in a curved path when propelled through a magnetic field. The particles are fired past a magnet, which deflects them in a manner proportional to their mass. Ions passing thru a prelocated slit (on continuous monitoring types) are picked up as an electrical current. This current is amplified and transmitted to recording or control equipment.

C. Refractometer

We are familiar with the rainbow produced when sunlight passes through water vapor in the air and is "broken up" into its component colors; each "color" is bent or refracted a different amount by the moisture and, therefore, appears as an individual color. Light (in the following considered to be monochromatic) passes through a gas at a rate or velocity characteristic of the gas. The light is bent or refracted at the interface of two media because its velocity differs in the two media. It is this bending characteristic which is measured.

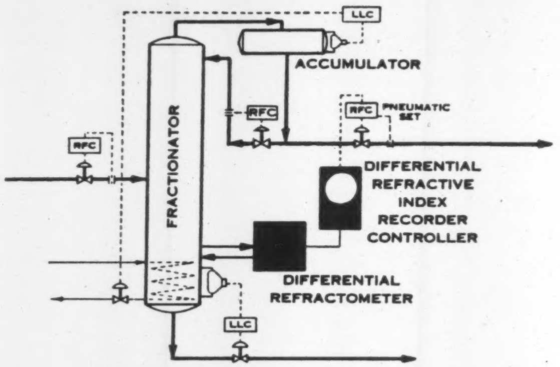

LLC
ACCUMULATOR
FRACTIONATOR
RFC
RFC
RFC
PNEUMATIC SET
DIFFERENTIAL REFRACTIVE INDEX RECORDER CONTROLLER
DIFFERENTIAL REFRACTOMETER
LLC

Fig. 3. Use of a Phillips 66 Differential Refractometer for control of a fractionating tower.

The light arriving at a specific point is measured by a photocell after passing through several prisms.

The refractive index of most materials has been published in the International Critical Tables and other references.

It should be noted that the factors which increase density (temperature, pressure molecular weight) also increase the refractive index. This is of interest in choosing sampling conditions which will give greatest selectivity.

D. Magnetic Susceptibility

Faraday postulated, many years ago, that all matter possesses magnetic properties to some extent. These substances fit into three categories depending on their magnetic permeability with reference to a vacuum—*diamagnetic*, *paramagnetic*, and *ferromagnetic*. A ferromagnetic substance has about 1,000 times the magnetic strength of a paramagnetic material. In a magnetic field, a paramagnetic (or ferromagnetic) rod will orient itself in the same direction as the field, whereas a diamagnetic will be perpendicular to the field. It is this orientation feature that permits proportional measurement.

The paramagnetic property of oxygen is the most widely used, although nitric oxide, nitrogen dioxide, chlorine dioxide, and many organic radicals have measurable paramagnetic properties. Paramagnetism may be expected in molecules or ions with an odd number of electrons.

E. Thermal Conductivity

Most thermal-conductivity equipments employ the *reference-cell* method. One cell is filled with a reference gas (often air) and the other with the sample, which may flow through the cell. Within each cell is a wire with a relatively high temperature-coefficient. These wires form two legs of a Wheatstone bridge. Electrical current is applied to the wires, which arrive at a temperature (and, therefore, a resistance) which depends on the ability of the sample and reference gases to conduct heat away from the heated filament to the cell walls. Hydrogen, having a coefficient of 7.10 at 100°, is analyzed for by this method. At the same temperature helium has a coefficient of 5.53, neon 1.84, ammonia 1.04, oxygen 1.014, air 1.00 (reference).

As all material conducts heat to some extent, the sample should be studied for interfering compounds. If the con-

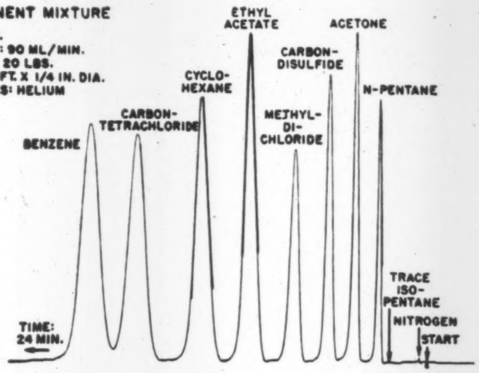


Fig. 4. Perkin-Elmer vapor fractometer uses principle of gas chromatography for analyzing gases and liquids boiling below 300°C.

centration of the interfering compound or compounds is fairly constant (say 10%), compensation may be made in one of two ways: the interfering compound can be put in the reference cell, or a resistance equivalent to increased resistance due to the lower temperature may be put in the circuit. If the concentration of the interfering substance varies too much, the thermal-conductivity method may have to be discarded in favor of another method, say mass spectrometry.

Specific-gravity instruments can also be used for hydrogen determinations.

F. Electroconductivity

Any material which is ionizable or which can be converted to an ionizable substance can be measured by electroconductivity methods. If the sample is in vapor form, it is dissolved in distilled water. Two electrodes are placed in the solution, and the amount of current passing between the electrodes is a function of the number or concentration of the ions. This current is measured by an a-c or d-c Wheatstone bridge.

The possibilities of this technique are only beginning to be appreciated. Consider oxygen which dissolves in water in small amounts, and what dissolves does not ionize. When it is required to measure oxygen down to 0.1 part per million, most other methods already described are not adequate. Purified nitric oxide (NO) is oxidized by the oxygen forming nitrogen dioxide (NO_2) which, when dissolved in water, forms ionizable nitrous acid.

Hydrogen sulfide may be oxidized or pyrolyzed to sulfur dioxide which forms sulfurous acid, which is measurable, or peroxide may be added to the water to form stronger acids. Many compounds are ionized or ionizable in themselves, such as chlorine, carbon dioxide, and chlorinated hydrocarbons.

It must be kept in mind that this type of instrument is not selective and that undesirable gases or vapors must be scrubbed or filtered out of the mixture.

The instruments described have proved to be reliable and accurate when properly applied in the process industries. There are many other instruments, not in common usage today, which will join them in the near future —radiological, chemical colorimetric, thermal convection, x-ray spectroscopy, dielectric constant, and others. A future article will discuss these lesser-known instruments.

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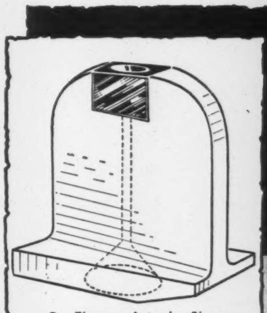

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Orifice	.013

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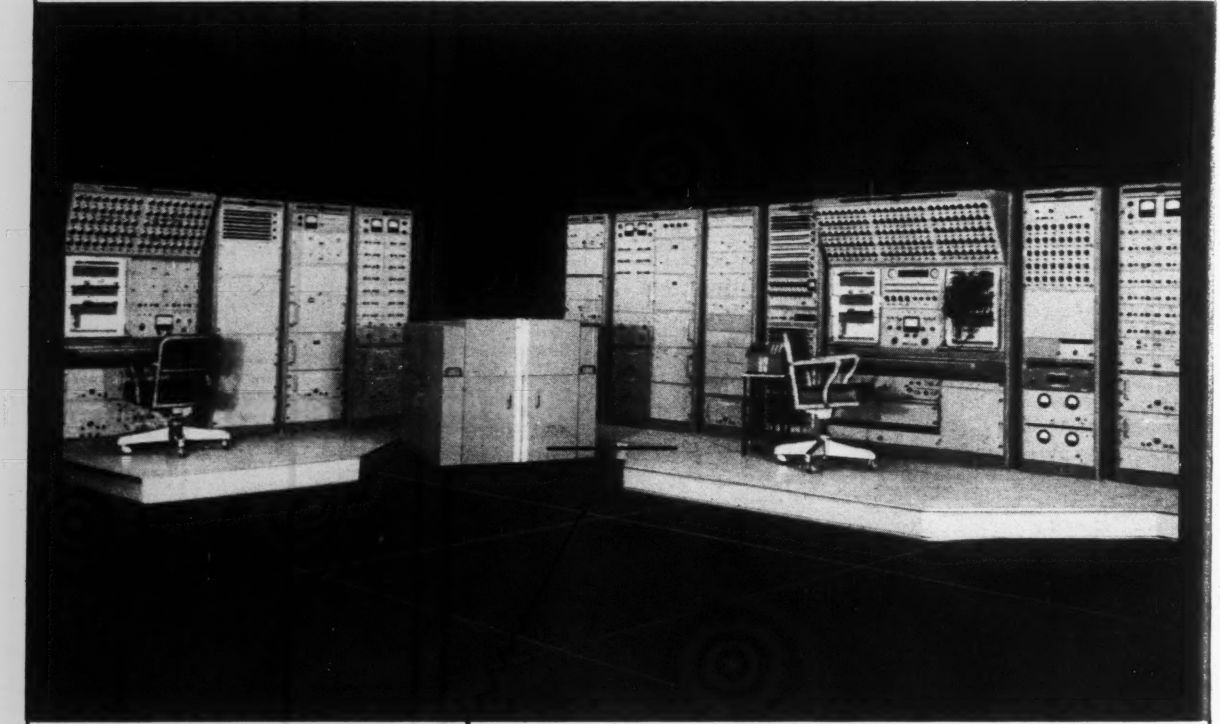

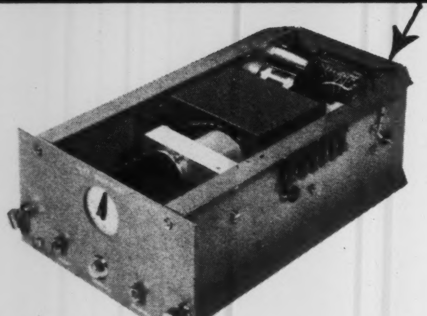

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The SIMULATION COUNCIL Newsletter

John H. McLeod, Jr., EDITOR

Suzette McLeod, SECRETARY

8484 LaJolla Shores Drive
LaJolla, Calif.

Western Simulation Council
Bill L. Waddell, Giannini DATEX Division, Pasadena, Calif.; Chairman, Steering Committee.

Midwestern Simulation Council
J. J. Stone, Battelle Memorial Institute, Columbus, Ohio; Chairman, Steering Committee.

Eastern Simulation Council
Frank Richmond, Glenn L. Martin Co., Baltimore, Md.; Chairman, Steering Committee

Southeastern Simulation Council
W. K. McGregor, ARO, Inc., Tullahoma, Tenn.; Chairman, Steering Committee.

Bits

Short Newsletter this month. What with changing jobs from Naval Air Missile Test Center, Pt. Mugu to Convair, San Diego, moving from Camarillo to La Jolla, buying new house, selling old, and lots of etcetera, your Editor hardly found time for Cinco de Mayo in Baja California, much less editing.

Besides, I was counting on giving you the word on the March 30 meeting and fishing trip of the Southeastern Simulation Council, but haven't heard a word from those guys since they "approved of (me) as the Chairman of the Steering Committee (of the National Simulation Council)." Then what did they do—secede? Probably not; probably just didn't catch any fish and would rather forget the whole thing!

Hal Coleman did, however, come through with his minutes of the Midwestern Simulation Council, so - - - -

Pieces

MEETING OF MIDWESTERN S/C OF MARCH 19 ON "MATHEMATICAL FORMULATION OF PROBLEMS"

The Cincinnati Milling Machine Company was host to the Midwestern Simulation Council on March 19th. The group met in the company's very plush main auditorium and was welcomed by the Director of Research, *Dr. Gene Merchant*, who discussed the growth of research in their business. The following highlights of the meeting were furnished by *Hal Coleman* (Research Laboratories, Bendix Aviation Corp., Detroit, Mich.) in his official minutes of the meeting.

Robinson on Formulating the Problem

Subject of the meeting was "The Mathematical Formulation of Problems." The first speaker, ex-Lieutenant *A. C. (Robbie) Robinson* (WADC, Wright-Patterson Air Force Base, Ohio) said that in the computer field there are those who think the problems up, and those who operate computers. Sometimes the same person will perform both functions to eliminate friction.

As mathematics permeates more and more the field of engineering, computers have entered the picture, especially in the more advanced mathematical aspects of the engineering problems. When an engineer starts to formulate a problem his knowledge of the field of computation may determine how he will proceed; if his knowledge of computers is limited his approach may also be limited.

Usually a problem starts with the simplest formulation rather than a complete analysis. Often the approach is dependent upon a knowledge of the computer equipment available. The average graduate has not had an opportunity to become familiar with computers; if he had, perhaps his approach would be different. Most simulation systems behave very much like the physical systems*, and hence the purpose of the simulation, along with the accuracies, should be determined. There should be a statement of the procedure, and of what is expected from the computer. There should be some form of data control as the danger of taking too much data is far greater than taking too little; the tendency is to get everything possible.** Checking the results should be a function of the man who formulated the problem, as he is the one who can best tell if the results make sense.

Milt Warshawsky (WADC, Wright-Patterson Air Force Base,

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*We hope.—Ed.

**Too true! The question should always be asked, "Is this information really necessary?" This is not so important in analog work where all data are usually available for the plugging in of a recorder, but with digital computers, where print-out is a real bottle-neck, one should ask, "Who, if anyone, is going to read and analyze all those figures?"—Ed.

Ohio) agreed that two people should be responsible for computer problems: one for the simulation and one for the operation. The computer operator represents the equipment and should be able to answer any questions the engineer asks during the simulation. Sometimes by cooperation it is possible to minimize the amount of computer equipment used by consolidation of the equations. Hence, if there are four variables and four equations, it may be possible to consolidate them into a single equation so that less computer equipment will be necessary, providing this does not cause recording difficulties.

P. J. Hermann (Goodyear Aircraft Corp., Akron 15, Ohio) asked, "Can formulation and computer operation be separated?". Robbie answered that the more each knows about the other's field the better; however if one is to do both he has to know a lot about several subjects, which is asking quite a bit from any one individual. The tendency at WADC is to use two people.

Hal Coleman indicated that a successful approach is the use of a team to work on a particular problem. The team consists of both analysts and computer personnel. The analysts' primary function is dealing with the problem from a project point of view, while the computer personnel are concerned with the operation of the computer. With such a team there is a minimum of cleavage between problem formulation and computer operation. Robbie said that the team system worked out well at WADC also.

Hermann remarked that at Goodyear the formulator generally sets up and operates the analog equipment, but that the digital installation operates almost exclusively as a computer operation service.

Dick Weber (Cincinnati Milling Machine Co., Cincinnati, Ohio) said he felt that it was a factor of the installation size. In his small facility it is possible to combine the persons* and achieve a high factor of economy.

Milt Warshawsky agreed. A large operating group needs a full-fledged engineer because of the nature and complexity of the computing equipment as well as the computing techniques. As an example, he described a large organization on the West Coast where the function of the computer group is purely maintenance. It was his understanding that problems on these facilities last for unreasonably long periods of time because no one in the computer operating group has the authority to get them off, whereas the formulating engineers are not computer specialists and therefore do not utilize the computing equipment to its maximum capabilities. So it is necessary for the organization to have large amounts of computer equipment which could be more efficiently used in a different type of organization.

Robbie feels that the formulator should stay with the computer all the time the problem is being run, to judge whether results are significant or not.

Larrowe on Direct Simulation

The next speaker was *Vernon Larrowe* (Willow Run Research Center, Ypsilanti, Mich.), who discussed "Direct Simulation." This tied in well with the previous paper by giving examples of formulation. First a simplified RLC network was set up, and the normal differential equations derived and put on a computer. The network consisted of two inductors, a capacitor, a resistor, and a voltage source. Solution of the differential equations describing the network required four integrators. However, examination of the network showed that only three integrators should be necessary.

Because the four-integrator solution gave poor results, another approach was taken, using the nodal equations describing the network. Again four integrators were involved and the results were unsatisfactory.

Vern then went back to the basic laws and by writing the current equations came up with a set of equations requiring three integrators, the proper number.

Then Vern demonstrated the advantage of using analog components to set up direct analogies of RLC networks. In a direct simulation the equations are not solved explicitly, but the analog components are set up so that each element of the network is replaced by comparable computer components. These derived circuits contain a minimum number of integrators and other computer components. The value of each inductance, capacitance, or resistance in the network being simulated can be set by a single potentiometer in the analog computer circuit. Vern said that this theory works well for complicated networks, and that an extension of it has been applied to mechanical systems with equal success.

Milt Warshawsky asked whether positive feedback leads to possible instability. Vern replied that they had experienced no trouble, but he did mention that in some instances a choice of variable signs had to be made for stability reasons.

Robbie asked about the size of the equipment, to which Vern answered that, in general, low-frequency amplifiers can be used and for most circuits only a few elements are needed.

The meeting was then adjourned for a conducted tour of the Cincinnati Milling Machine Company. Most of the group had never been in a milling machine manufacturing company before, and were surprised at the cleanliness in the shops, the low noise level in the large engineering offices, and the lighting arrangements which made fluorescent lights almost unnecessary.

After the tour the group was informed that Howard Hamer (Electronic Associates, Inc., Long Branch, New Jersey) couldn't make it because of the unusually heavy snow fall that had closed the New York area.*

Bill Parks (Carbide and Carbon Chemicals Co., Oak Ridge, Tenn.) asked about "the evaluation of known facts" by simulation, and how to set up such a problem. Their difficulty, he said, is that in the chemical industry they usually cannot follow equations. How, he asked, does the aircraft industry check the actual operation as compared with the computer problem on a data basis? Robbie answered that the form of the equations must be determined empirically by making educated guesses, then pots representing the coefficients can be twisted until the results agree with those measured.

Jim Stone (Battelle Memorial Institute, Columbus, Ohio) asked the reasons for simplification. Hermann indicated that at Goodyear they simplify to make sure they are on the right track. Jim then brought up the philosophical question of going from the simple to the complex vs. establishing the complex system, then simplifying it. Bill Parks said that in the chemical business they combine both and go back and forth to get the best agreement. Robbie's group uses the

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*Now they are combining *persons* in the lab. Tsk, tsk!—Ed.

*Ye Ed cannot resist such an opening for a plug (didn't try very hard!). It never snows (and seldom rains) in San Diego, but snow sports are available within a few hours' drive for them as wants it. Address all inquiries to 8484 La Jolla Shores Drive, La Jolla, Calif!

simplified setup to see whether the system checks, and then expands the setup to account for the complicated system. If a person doesn't know the computer, he will tend to stop too soon because he cannot fully imagine the capabilities of simulation.

Hermann told about reducing the number of amplifiers on one of his problems from 40 to 3 with simplifications which did not change the system performance. Hal Coleman remarked that it is sometimes hard to sell the problem formulator on this type of simplification. The formulator is always afraid that perhaps the insignificant term may become important later. Jim observed that it is easier to teach accountants to work a digital computer than to teach digital computing operators accounting, and wondered if this was applicable to analog computers. Vern Larrowe said he preferred the team concept, but believed that it was easier for analog computer people to learn other problems than vice versa. Computers should be a representation of the system. If you are using numbers you are computing, and if you are using variables you are simulating.

Information (Without Theory)

Simulation Council Cousin Is Born!

At Stan Rogers' instigation, Convair-San Diego was host on May 18th to 28 representatives of 13 organizations who either have or expect to get *digital differential analyzers.* The group met at the Institute of Aeronautical Sciences in San Diego to consider whether or not any kind of organization should be formed by and for those interested in digital differential analyzers, and if so, what sort of organization it should be.

Result of the meeting: They decided to form the DDA Council, to be patterned along the lines of the Simulation Councils and to be kept as informal as possible. Stan Rogers was elected temporary Chairman, to serve until the next meeting. This will be held in Long Beach, California on 20 August 1956 (the day preceding WESCON).

Meetings of the DDA Council will be open to all and everyone is invited to participate in the discussions. For further information address Stan Rogers at 3023 Alcott Street, San Diego, Calif.

* * *

In one of the rare business sessions of the Western Simulation Council your Editor, in his capacity of Chairman of the National Simulation Council, led a discussion to determine the sentiments of those present on two aspects of the next NSC meeting, i.e., what kind of meeting and where. It was unanimously decided to hold an informal meeting in connection with a formal meeting of some other organization, as opposed to a formal meeting of our own. Furthermore, the Third International Automation Exposition to be held in the New York Trade Show Building, 26-30 November, received a clear majority of the votes as the organization to team up with. And lest anyone thinks that he recognizes the fine Scotch hand of ye Ed. in this affair, let me remind him that though I would most like to see it held in connection with the High-Speed Computer Conference in Baton Rouge, Louisiana (because of the geographical and temporal proximity to the New Orleans Mardi Gras), I realistically voted for the AIEE meeting in San Diego because it would be easiest for me to make the arrangements!

* * *

Received a very nice letter from Mr. J. J. Moses of Ryan Aeronautical Company, Lindberg Field, San Diego 12, Calif., U.S.A. Seems they are looking for an engineer (whoinhell isn't?) to head up their Analog Computing Facility. Sounds like a good job with a promising future. I sincerely wish I knew someone I could recommend to Mr. Moses—I'd hire him myself!

* * *

Are you familiar with the learned (it really is) paper which appeared in the *Economist of London,* issue of 15 November 1955, "How Seven Employees Can Be Made To Do the Work of One"?

Some excerpts:

"It is commonplace observation that work expands so as to fill the time available for its completion. Thus, an elderly lady of leisure can spend the entire day in writing and dispatching a postcard . . . The total effort which would occupy a busy man for three minutes all told may . . . leave another persons prostrate after a day of doubt, anxiety, and toil.

"There need be little or no relationship between the work to be done and size of the staff to which it may be assigned. Before the discovery of . . . Parkinson's Law . . . there has, however, been insufficient recognition of this fact in the field of public administration. Politicians and taxpayers have assumed . . . that a rising total in the number of civil servants must reflect a growing volume of work to be done. Cynics, in questioning this belief, have imagined that the multiplication of officials must have left some of them idle or all of them able to work for shorter hours. But this is a matter in which faith and doubt seem equally misplaced. The fact is that the number of the officials and the quantity of the work to be done are not related to each other at all. The rise in the total of those employed is governed by Parkinson's Law, and would be much the same whether the volume of the work were to increase, diminish, or even disappear. The importance of Parkinson's Law lies in the fact that it is a law of growth based upon an analysis of the factors by which that growth is controlled.

"Omitting technicalities . . . we may distinguish, at the outset, two motive forces . . . (I) An official wants to multiply subordinates, not rivals; and (II) Officials make work for each other."

The author then examines the Law of Multiplication of Subordinates, the Law of Multiplication of Work, gives examples and Scientific Proofs supported by statistics, and concludes with the Formulation of the Law.

"In any public administrative department not actually at war, the staff increase may be expected to follow this formula:

$$x = (2k^m + p)/n$$

where k is the number of staff seeking promotion through the appointment of subordinates; p represents the difference between the ages of appointment and retirement; m is the number of manhours devoted to answering minutes within the department; and n is the number of effective units being administered. Then x will be the number of new staff required each year."

"Mathematicians will, of course, realize that to find the percentage increase they must multiply x by 100 and divide by the total of the previous year, thus:

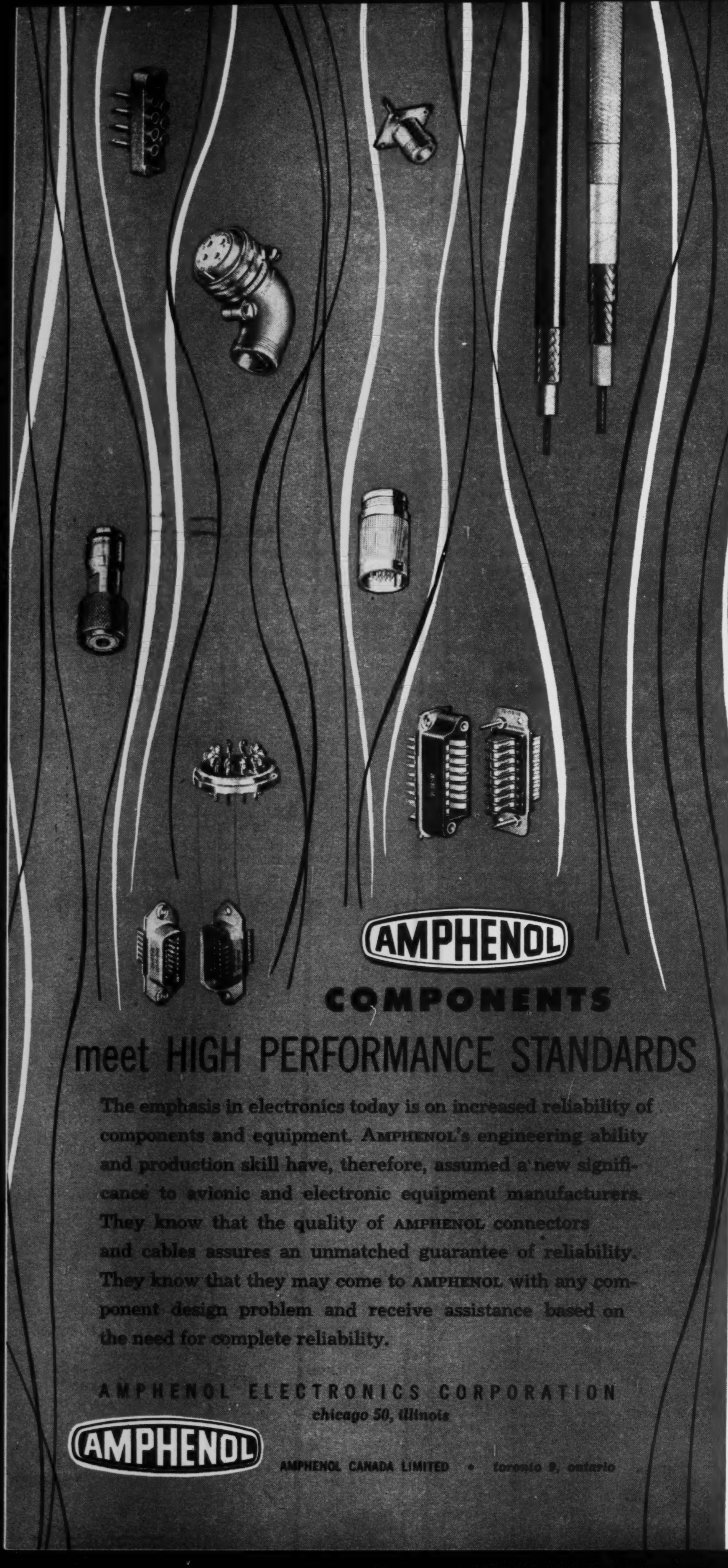
$$\frac{100\ (2k^m + p)\%}{yn}$$

where y represents the total original staff. And this figure will invariably prove to be between 5.17 percent and 6.56 percent, irrespective of any variation in the amount of work (if any) to be done.

". . . Those who hold that this growth is essential to gain full employment are fully entitled to their opinion. Those who doubt the stability of an economy based upon reading each other's minutes are equally entitled to theirs . . ."

He Went Thataway!

Norm Irvine to Mid-Century Instrumatic Corp. Norm says that though he will be Western sales representative as well as in charge of West Coast research and develop-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ment, he will always be an engineer first and salesmen second. We believe you Norm. Good luck!

Thot (from Experience)

If any of you are considering a change of employment which will involve a move, and can't stick someone else for the moving expenses, call your favorite charity to come get everything you own. Otherwise the moving company will demand more *cash* when they sell your furniture back to you than you probably paid when you got it originally.

Computer Events

Other events on page 1062

Midwestern Simulation Council
Date: Monday, 9 July 1956
Place: Detroit Tank Arsenal
Centerline (Detroit), Mich.

Western Simulation Council
Date: Thursday, 12 July 1956 (tentative)
Time: 1:00 PM
Place: Convair, San Diego, Calif.
Subject: "Combined Analog and Digital Simulation" Confidential security clearance will be required. The man to see is Stan Rogers, Building 51, Plant 1.

An interesting demonstration of high-speed digital-to-analog-to-digital conversion is planned. Come see!

Eastern Simulation Council
Date: 16 July 1956
Place: Electronic Associates Computation Center, Princeton, N. J.
Subject: "Use of Noise in Simulation." Contact Bernie Loveman at Reeves for details.

WESCON
Dates: 21-24 August 1956
Place: Los Angeles, Calif.
For information write to WESCON, 344 N. La Brea, Los Angeles 36, Calif.

Association for Computing Machinery
Dates: 27-29 August 1956
Place: University of California at Los Angeles, Los Angeles, Cal.
Subject: 11th Annual Meeting
Correspondence concerning arrangements should be sent to ACM, Box 3251, Olympic Station, Beverly Hills, Calif.

← Circle 63 on inquiry card.

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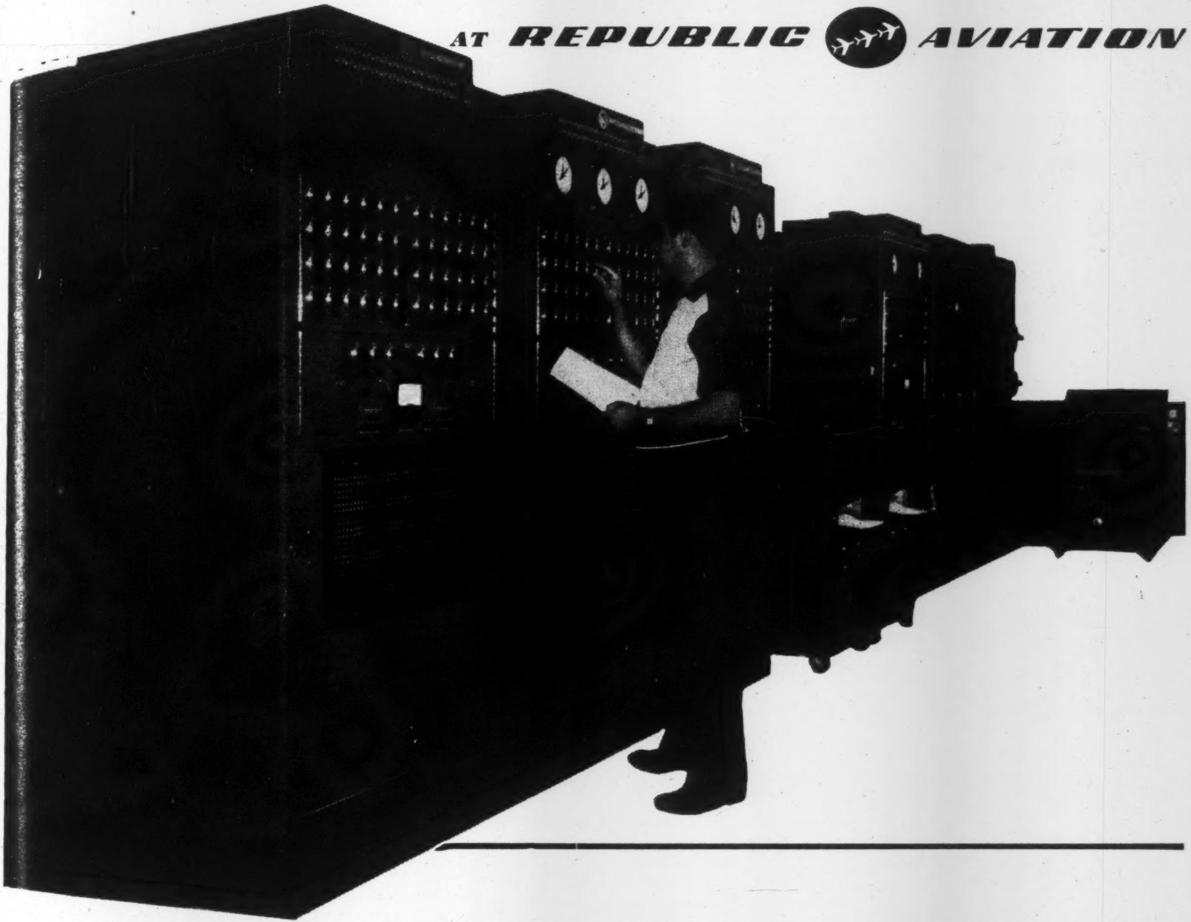

Where huge savings in time and costs will be realized!

Because Republic can "fly" an aircraft or guided missile, including take-off, cruise, landing, maneuvers and emergency conditions right in this computer center. Here, the actual performance is actually and accurately simulated, in a safe and in a relatively inexpensive manner. Here the optimum in design characteristics is determined without endangering human lives or incurring losses of millions of dollars with test flight models.

Every industry that now utilizes test models can save millions of dollars in time and model costs with a Mid-Century analogue computer center. Every industry that needs production or automation controls can do likewise by substituting Mid-Century analogue computers to more easily and cheaply adjust their manufacturing processes to a higher optimum of production with greater uniform quality.

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ASCO

the *one* source for RELAYS that offers engineers complete design flexibility

The designer confronted with the specification of a relay has a genuinely unusual opportunity when he discusses his problem with an ASCO engineer. For the ASCO representative can suggest a relay for use as a unit, or as a control panel component, and meet the designer's need *exactly:*

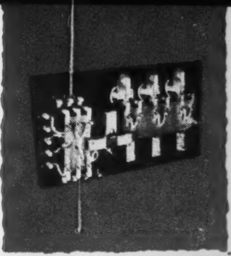
> ASCO offers both magnetically and mechanically held relays — both available with up to 12 poles normally open or normally closed — in 10 and 25 ampere sizes, AC and DC.
>
> In addition, ASCO lists a highly diversified line of special purpose relays as *standard catalog items.*
>
> Finally, should any of these relays fail to meet specialized requirements — ASCO will design and manufacture one or more that will.

And most important —

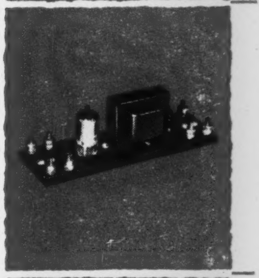
For assured performance, ASCO Relays are current and voltage rated "make" and "break". Almost unlimited pole combinations mean fewer relays in a system — more reliable operation. Adaptability of many proven contact materials, arcing contacts, blowout coils and Class H insulating materials to ASCO Relays means suitability for all applications.

With this complete flexibility the designer can select a relay that meets his requirements, rather than have the relay limit his design.

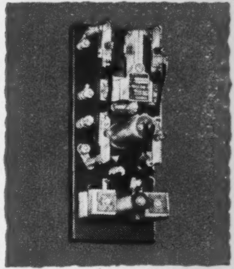
There's *one* source that solves virtually any relay problem — ASCO. Why not have the ASCO engineer call — or write outlining your relay problem. We'll be pleased to assist you.



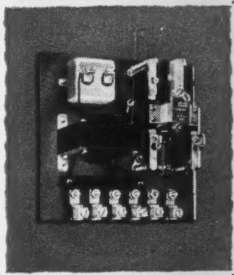
For Computers —
This relay, designed to meet specific requirements, provides the ability to interrupt inductive loads through blowout coils and arcing contacts. A unique control combination obtains low resistance.



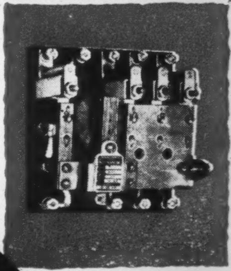
Electronic Relays —
Extremely sensitive, for high speed response. "Brushing" of control leads — even momentarily — provides positive relay operation. Available, too, with time delay.



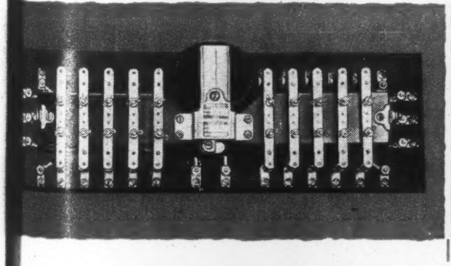
Time Delay Relays —
Provide accurate, fixed time delays from ½ to 3 seconds when relay is de-energized — make power switching devices "chatterless."



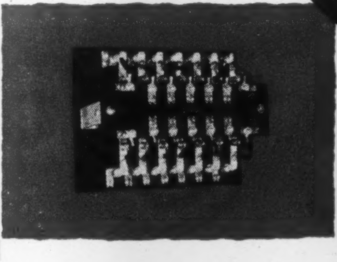
Close Differential Relays —
Operate on voltage or current differential of .2% — less if required. Adjustable drop-out is standard. Adjustable pick-up is available.



For Power Amplifiers —
This relay resists high inrush current of transformer loads — withstands severe arcing. Special contact material endures high ambient temperatures.



Many application requirements are met and surpassed with standard ASCO Magnetically Held Relays. For example, the Bulletin 1055 Relay adapts readily to such specialized control applications as control circuit transfer relays and mechanically interlocked relays for reversing motors.



This standard ASCO Mechanically Held Relay — Bulletin 1256 — withstands severe shock and vibration — is used extensively for mobile units, central station control units and circuit transfer relays.

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Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

Automatic Switch Co.

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INSTRUMENTS and AUTOMATION

New Instruments

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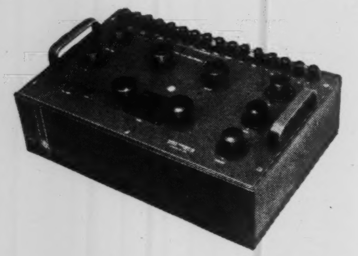
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1235

ELECTRICAL and ELECTRONIC INSTRUMENTS

POTENTIOMETER

New "Type K-3 Universal Potentiometer," for calibration of indicators and recorders, calorimetry, precise voltage measurements of direct voltages, precise temperature measurements, etc., has a unique reading window that centralizes 3 or 4 dial readings into one row of digits plus a scale value. Other new features include guarding of instrument circuit against static, leakage and effects of high humidity; and elimination of thermal emf's. An auxiliary potentiometer circuit and connections provide selection of reference potentials to permit use as "double" potentiometer. Available for bench-type or relay-rack type mounting.—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.*



For more information circle **201** on inquiry card.

TRANSISTOR VOM

New "Model 400 Transistor Multimeter" is a transistorized portable supersensitive volt-ohmmeter that measures direct and alternating voltages as low as 0.03 full-scale; sensitivity 200,000 ohms/volt. It is said to be capable of measuring "very low values of resistance" with a mid-scale reading of 1 ohm.—*New London Instrument Co., 31 Union St., New London, Conn.*

For more information circle **202** on inquiry card.

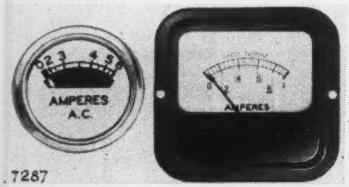
RACK-MOUNTED DIGITAL VTVM

New "Model 615R" mounts in a standard 19" rack, features an automatic "off-scale" indicator and illuminated decimal-point and polarity signs. Sensitivity 1 mv on low scale; accuracy 1% on dc and resistance, 2% on dc. Special accuracy of 0.1%, as well as complete facilities for automatic print-out, available on special order.—*Hycon Electronics, Inc., 321 So. Arroyo Parkway, Pasadena, Calif.*

For more information circle **203** on inquiry card.

PANEL INSTRUMENTS

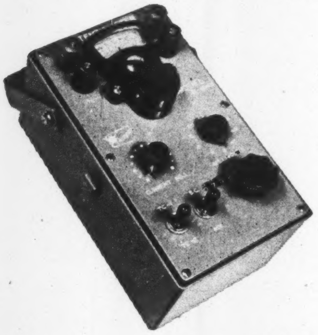
Newly designed "Panel Type A.C. Meter" is produced and sold at savings to user of up to 20% over maker's former models. No sacrifice of quality. Radical change of solenoid construction allows instrument to withstand 300% overload. It is also possible to supply desired pointer damping to control swing, and scale calibration can be arranged as desired. All shapes, sizes, dial arrangements and colors.—*Sterling Mfg. Co., 7201 Wentworth St., Cleveland, Ohio.*



For more information circle **204** on inquiry card.

DIGITAL-DIAL POTENTIOMETERS

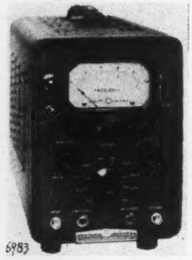
New "P-55A" (aluminum case) and "P-55MA" (mahogany case) portable potentiometers with 4-place digital readout measure 4⅛" x 7½" and weigh 3½ lb, yet are accurate to 0.1% of range.—*Alleghany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Md.*



For more information circle **205** on inquiry card.

FREQUENCY METER

New "Model 500B" high-accuracy frequency meter with expanded scale covers frequencies 1 cps to 100 kc; provides direct readings accurate within 2% full scale. Expanded scale permits any 10% or 30% segment to be viewed full scale. Input requirements: 0.2 v on sine waves and 1 v minimum to 250 v peak maximum on pulsed signals. In addition to output for a recorder, a pulsed output is provided to synchronize a stroboscope. Readings are never affected by signal or line voltage variations.—*Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif.*



For more information circle **206** on inquiry card.

DIRECT-CURRENT VTVM

New "Model 200B" combines high input impedance of maker's earlier Electrometers in a compact battery-operated dc vacuum-tube voltmeter

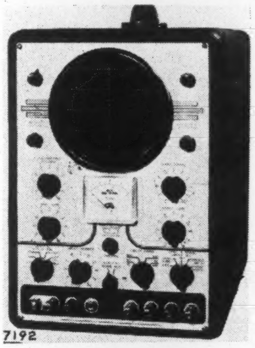
VOLTS
dc VTVM
6998

with much greater sensitivity: It is over 100 times as sensitive as "Models 200 and 200A," hence wide application in lab and field. Input impedance over 10^{14} ohms; grid current less than 5×10^{-14} amp; full-scale accuracy within 2%; 8 voltage ranges from 0.008 to 20 v full scale of either polarity.—*Keithley Instruments, Inc., 3868 Carnegie Ave., Cleveland 15, Ohio.*

For more information circle **207** on inquiry card.

CATHODE RAY OSCILLOSCOPE

New "Model 3441-A" is the first commercially available CRO with provision to permit changing polarity to vertical input amplifiers and thus keep wave-form on CRT showing in a conventional manner. Other features include calibrated voltmeter; multivibrator type internal sweep generator to provide linear sweep voltages up to 60 kc; return trace eliminator; 5" CRT with telescoping light shield; internal phase controlled horizontal sweep of supply frequency facilitating use of scope with sweep generators.—*Triplett Electrical Instrument Co., Bluffton, Ohio.*



7192

For more information circle **208** on inquiry card.

AC AND DC RECTANGULAR INDICATING INSTRUMENTS

New "Models 68 and 69" 4⅝" rectangular instruments permit maximum scale length; are made for semi-flush panel mount applications; are supplied with external zero adjust. New illumination technique (optional) permits bulb replacement or service from front of case without

2
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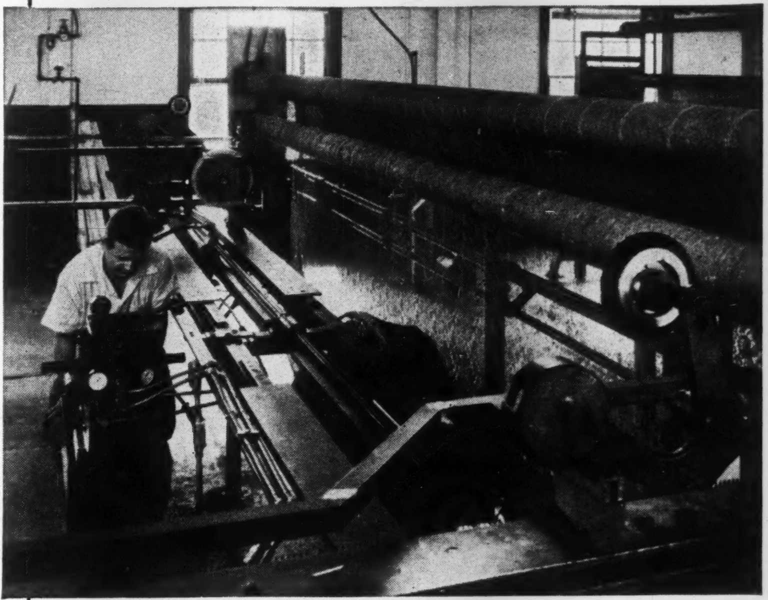
MILLIAMPERES
DIRECT CURRENT

7151

FROM...

Tons of Steel to Ounces of Lace Rolls of Paper or what YOU Make



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WIDE RANGE

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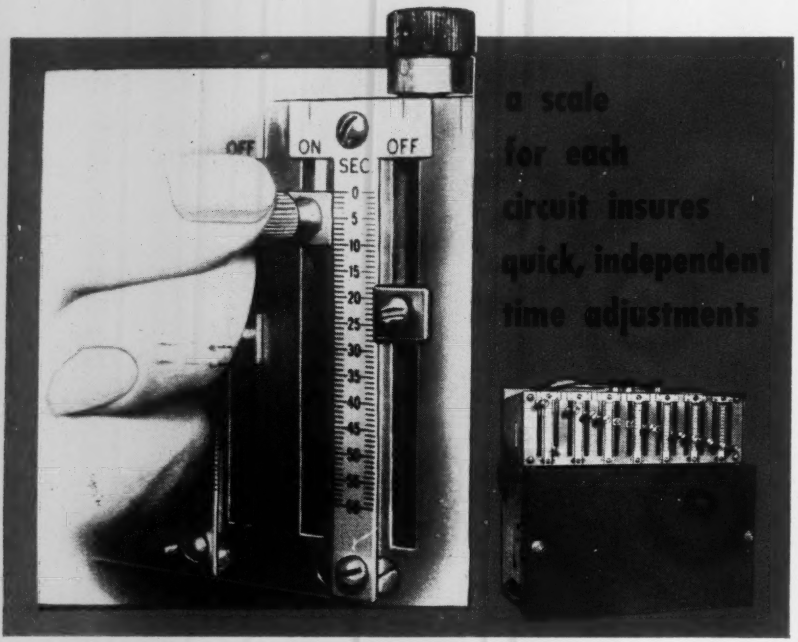
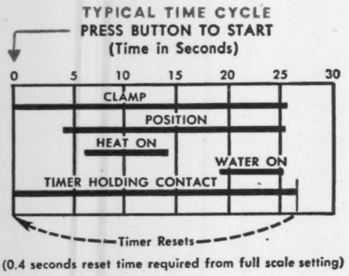
For more information circle **67** on inquiry card.

EAGLE MULTIFLEX
(multiple circuit) reset timer



For controlling operation phases of electrically energized devices in processing work. The Multiflex Reset Timer closes and opens one to six circuits during a time interval started by push button, limit switch or other means. It's the only multiple circuit timer that provides a calibrated scale for quick, independent adjustment of each circuit. Time changes are made rapidly by moving a simple slide adjustment. Settings are possible to 1% of full scale. Vernier knobs are provided for use where more accurate settings are required. Multiflex Timers are available with time scales from 30 seconds to 5 hours. Send for free bulletin.



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MOLINE, ILLINOIS

Please send Bulletin 130 containing full data on Multiflex Reset Timer.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

For more information circle **68** on inquiry card.

removal from panel. All electrical connections are made at rear. New movement utilizes an Alnico magnet four times as powerful as previously-used magnets of same size. Reduced body diameter allows for a smaller cutout of panel. Steel cup magnetic shield is available—*Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio.*

For more information circle **209** on inquiry card.

RECTANGULAR ELECTRICAL INDICATING INSTRUMENTS

New line of "3½" Rectangular Custom Meters" features a die-cast bezel that can be finished in either polished chrome and black or in a solid black; will enhance the appearance of users' equipment; can be obtained in colors to match or blend with users' panels; can be self-illuminated if desired; are available in all standard ranges and can be ordered with special ranges, personalized scales and color-matched bezels.—*Phaostron Instrument and Electronic Co., 151 Pasadena Ave., South Pasadena, Calif.*

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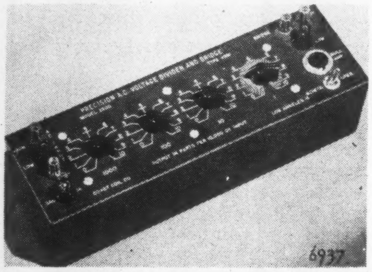
MILLIAMPERES
D.C.
7268

For more information circle **210** on inquiry card.

AC VOLTAGE DIVIDER AND BRIDGE

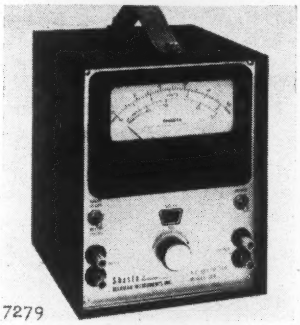
New "Model 2200" combines a precise ac voltage divider with a self-contained bridging transformer, constituting essential elements of a precision ac bridge. Accuracy 0.004% of input; resolution 0.0005% of input. Two types of precision ac voltage divider cover frequency range of 30 cps to 4 kc and higher and input voltages including 115 volts, 400 cps; two types of bridging transformer cover a similar frequency range. Curves allow user to know exactly the maximum error present in any bridging measurement.—*Coast Coil Co., 5333 W. Washington Blvd., Los Angeles 16, Calif.*



For more information circle **211** on inquiry card.

LOW-FREQUENCY VTVM

New "Model 204 AC Vacuum Tube Voltmeter" accurately measures 0.03 to 300 vac full scale in the low-frequency range of 2 cps to 300 kc; features regulated power supply, 8¾" effective scale length, illuminated range selector switch which displays only range in use.—*Shasta Div., Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif.*



For more information circle **212** on inquiry card.

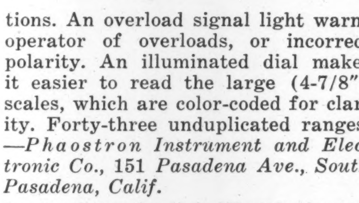
VOLT-OHM-MILLIAMMETER

New "666" VOM is fused to prevent most common burn-outs and instrument damage through misapplications. An overload signal light warns operator of overloads, or incorrect polarity. An illuminated dial makes it easier to read the large (4-7/8") scales, which are color-coded for clarity. Forty-three unduplicated ranges. —*Phaostron Instrument and Electronic Co., 151 Pasadena Ave., South Pasadena, Calif.*

For more information circle **213** on inquiry card.

WIDE RANGE OHMMETERS

Newly redesigned "Models 244 and 246 Precision Ohmmeters" feature compensation for change in internal



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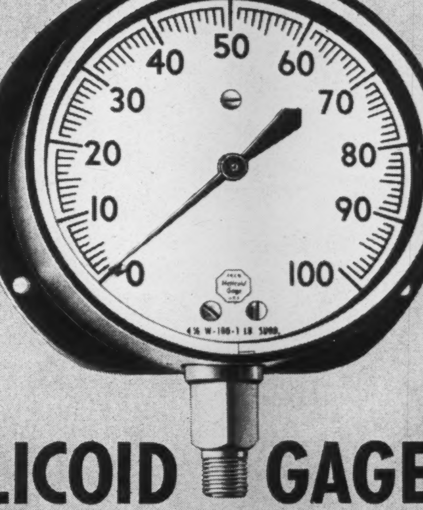
Helicoid Gages



How HELICOID GAGES can save YOU money!

LONG LIFE:

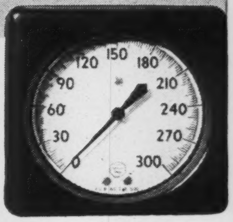
HELICOID Gages are pressure instruments of extreme precision and long, trouble-free service with minimum maintenance. Have no gear teeth to wear out.

SUSTAINED ACCURACY:

HELICOID Gages have many unique and exclusive features which result in the highest degree of gage accuracy. Tubes, for instance, will withstand hundreds of thousands of pressure pulsations and will not stretch, leak or crack.

JOB-DESIGNED:

HELICOID Bourdon tubes are made from seamless tubing of alloy steel, K Monel, stainless steel or phosphor bronze. Each is designed to give best service under specific conditions. Available in complete line of cases for wall or stem mounting.



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For more information circle **69** on inquiry card.

FLIGHT INSTRUMENTATION by RAHM

- PRESSURE
- ALTITUDE
- AIR SPEED
- ACCELERATION
- PRESSURE SWITCHING
- ALTITUDE CONTROL

Potentiometer type transducers for use at temperatures between —60° C. and +120° C.

Designs available permit single or multiple range linear output from non-linear input function, and operation over wide ranges of environmental conditions.

Designs available for operation to 160° C.

Special instruments for use with corrosive oxidants and fuels are available.

Specifications available on request.

RAHM
INSTRUMENTS, INC.
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NEW YORK 7, N. Y.

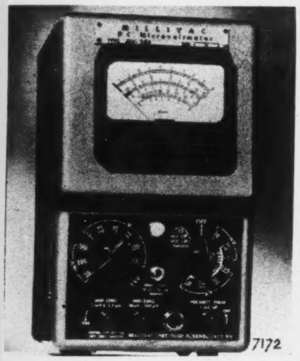
For more information circle **70** on inquiry card.

resistance of batteries due to aging, and for lead and clip resistance. "Model 244" has ranges of 0/50/500/5000/50,000 ohms, with lowest cardinal point of 0.05 ohm at ⅛" from zero. "Model 246" has ranges of 0/100/1000/10,000/100,000 ohms, with LCP of 0.5 ohm at $\frac{1}{16}$" from zero Both have accuracy of 1/32" at any point on scale or 0.5% at center scale; hand-stepped scales; built-in standard resistor for calibration check.—*Associated Research, Inc.*, 3767 *Belmont Ave., Chicago* 18, *Ill.*

For more information circle **214** on inquiry card.

COMBINATION TRANSISTOR AND VACUUM-TUBE DC VM

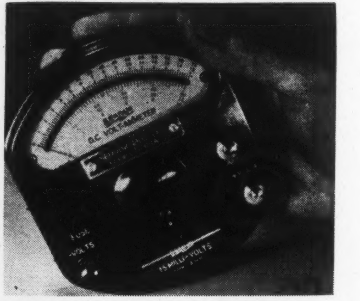
New "MV-35A VTVM and TRVM" is said to "set a new record in dc voltage-measuring sensitivity"; has unusually wide voltage range of 1 uv to 1000 v (1 to 1 billion). Its high-impedance chopper-type dc amplifier circuit covers ranges from 1 mv to 1 kv full-scale; low-impedance direct-coupled "hushed" transistor amplifier for more sensitive ranges (lowest 0 to 10 uv).—*Millivac Instrument Corp., P. O. Box* 997, *Schenectady, N. Y.*


7172

For more information circle **215** on inquiry card.

DC VOLT-AMMETER

New "Model A", is said to provide "a few advantages which are new in electrical measuring devices." Main features: (1) relay protection against overload; (2) plug-in type shunts and series resistors; (3) flexible whip type pointer. Instrument can be purchased with one or forty ranges from 10 ma to 25 amp and from 15 mv to 250 v. Full-scale sensitivity 200 ohms per volt; accuracy 0.5%. Meets all essential requirements of A.A.R. specs.—*SenDur Mfg. Co.*, 3225 *N. Sheffield Ave., Chicago. Ill.*



For more information circle **216** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

INSTRUMENT TRANSFORMER

7146

New "JCS-0" 600-v butyl-molded instrument transformers, for indoor use switchboard and switchgear applications, is available in all standard ASA current ratings from 200:5 to 4000:5 amp. Frequency is 50/60 cps and thermal rating is 100% of rated current at 55°C ambient and 133% at 30°C. Two window diameters: 4½" for 200:5 to 600:5 amp ratings and 5⅜" for 800:5 to 4000:5 amp ratings.—*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **217** on inquiry card.

VOLT-AMMETER ADAPTER

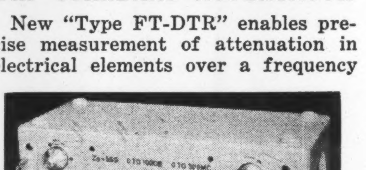
New plug-in adapter greatly extends use of maker's "Model 749" miniature ac clamp volt-ammeter: it has plug receptacles on either side: one reduces scale range by a factor of 10, the other is for reading ampere scale directly. Voltage readings are made by plugging probes into plug receptacles on either side.—*Weston Electrical Instrument Corp.*, 614 *Frelinghuysen Ave., Newark* 5, *N. J.*

7092A

For more information circle **218** on inquiry card.

VHF STANDARD ATTENUATOR

New "Type FT-DTR" enables precise measurement of attenuation in electrical elements over a frequency


6760

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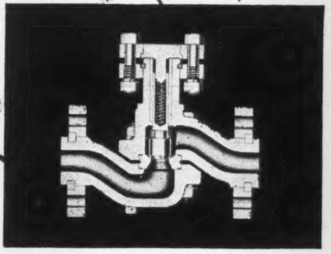
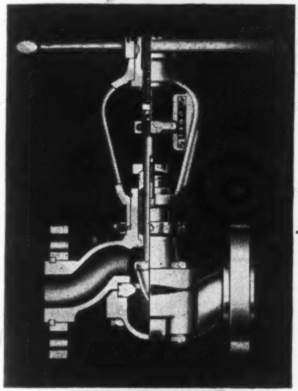
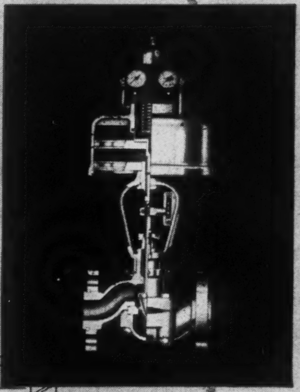
The complete line of Fluid Control Valves to meet every installation requirement



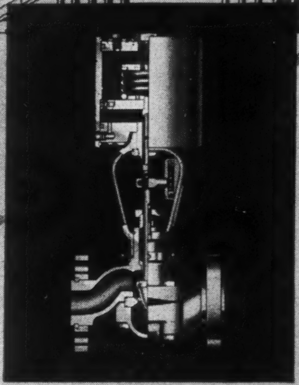
CHECK VALVE



HANDWHEEL VALVE



DOMOTOR VALVE



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Yes, *Annin* offers design and control engineers a complete line of valves for rugged and reliable performance "around-the-clock." Name the installation—rocket stand, aircraft component test facility, chemical plant, refinery, paper mill or power plant—and *Annin* valves will exceed the most critical performance needs, with features like:

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For more information circle **71** on inquiry card.

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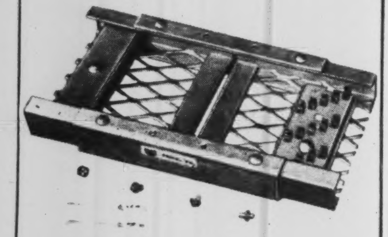
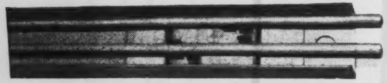
P.W

for Supporting
Instrument Tubing



P-W Manufactures a complete trough system with channel connectors. Drive rivets are used for quick assembly.—Extension Connectors eliminate field cutting—Adjustable connectors for any change in direction or elevation—I Section for long spans—Tube Clips—Cushion Clamps



Raceway to support a limited number of tubes with connectors, elbows, tees, etc.—Bulkhead Bar. P-W systems are available in widths from 1" to 24" and in lengths from 1' to 16'.

Twist-Rack

The Structure To Support Tubetrof . . . Cabletrof . . . Shelving . . . Conduit . . . Cables . . . Pipe, Etc.

Write today for Bulletin 955-D

P-W INDUSTRIES, INC.
Duncan & Melrose Sts.,
Philadelphia 24, Pa.

(Representatives to serve you!)

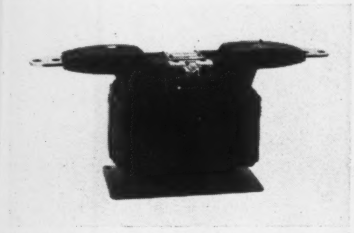
For more information circle 72 on inquiry card.

range from dc to 300 Mc; provides accurate attenuation from 0 to 100 db in 1-db steps, with ease of operation equal to or better than that usually associated with low-frequency attenuators.—*Instrument Div., Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J.*

For more information circle **219** on inquiry card.

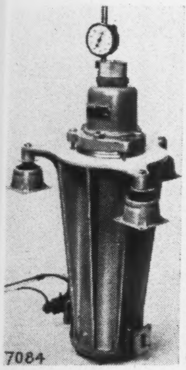
CURRENT TRANSFORMER

New "JKS-5" 15-kv butyl-molded indoor instrument current transformer for switchgear applications is available in all standard ASA current ratings from 15:5 to 800:5 amp; replaces present "JS-1" asphalt-insulated design.—*General Electric Co., Schenectady 5, N. Y.*



For more information circle **220** on inquiry card.

HIGH-Q CAVITY



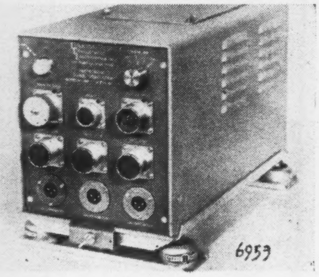
7084

New "VA-1280 Stalo Cavity" is a commercially-practical high-Q Cavity, featuring high stability without electronic components, provides a high degree of short-time frequency stability. Stability of "VA-1280" when used with maker's new highly stable reflex klystron oscillator is said to be "comparable to that of many crystal-controlled oscillators."—*Varian Associates, 611 Hansen Way, Palo Alto, Calif.*

For more information circle **221** on inquiry card.

SIGNAL CONVERTER

New "Model 108 Three-channel Instrument Signal Converter" for aircraft and laboratory measurements accepts signals from 400-cps pickups and drives conventional magnetic galvanometer recording devices. Frequency- and voltage-regulated power is supplied to pickups from unregulated power, and a large demodulated signal output with 0.5% linearity is available without amplification.—*—Dynalysis Development Labs., Inc., 11941 Wilshire Blvd., Los Angeles 25, Calif.*

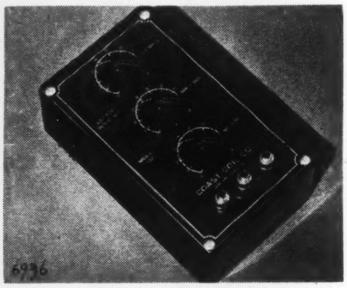


6959

For more information circle **222** on inquiry card.

DECADE INDUCTOR

New "Model 100," small in size and reasonable in price, is said to be high in performance; covers inductance range of 10 mh to 9.99 henries in steps of 10 mh. Its high-*Q* inductors are adjusted to a tolerance of 2%.—*Coast Coil Co., 5333 W. Washington Blvd., Los Angeles 16, Calif.*



6936

For more information circle **223** on inquiry card.

COAXIAL ATTENUATOR PAD

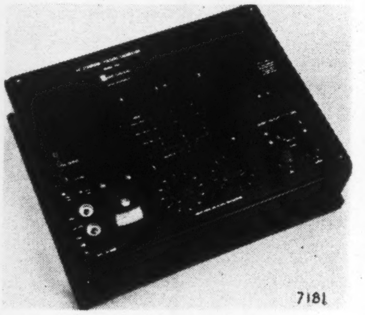
New "Model 210" of maker's 50 ohm coaxial attenuator pad embodies significant improvements. Accuracy improved by a factor of 5: absolute accuracy at 400 Mc at room temperature 0.1 db of nominal value. Temperature coefficient 0.00043 per db per F deg. Pads are available in 1-db steps from 1 to 10 db; frequency range 1000 to 10,000 Mc.—*Weinschel Engr. & Mfg. Co., 10503 Metropolitan Ave., Kensington, Md.*

7091

For more information circle **224** on inquiry card.

AC CALIBRATOR

New "High Precision AC Standard Voltage Calibrator" is useful wherever a moderate amount of power is required with voltages accurate to better than 0.1%. Calibrations can be made at voltages from 100 uv to 12



7181

for HAZARDOUS LOCATIONS

SKINNER
ELECTRIC VALVES

SKINNER EXPLOSION-PROOF Solenoid Valve
Only $3\frac{27}{32}''$ high

Skinner X5 Series Explosion-Proof stainless steel Valves are ideal for use in hazardous applications. They are Underwriter Approved for Class I (Gasoline vapors, etc.), and Class II, Groups F (Grain dust) and G (Coal and coke dust), and offer you incomparable simplicity and flexibility of design.

These low-cost valves are expertly engineered to give trouble-free performance through millions of cycles. They're direct-acting, leakproof and spring loaded for operation in any position. Available in a wide range of types, voltages, pressures, flow control adjustments, port sizes and port locations.

SPECIFICATIONS: Type: Two- and Three-Way Normally Open, Normally Closed, and Directional Control; Pressure Range: 0-1000 p.s.i. Orifice Diameters: $\frac{3}{64}''$ to $\frac{1}{4}''$. Pipe size: $\frac{1}{8}''$ or $\frac{1}{4}''$ NPT; Voltage All AC and DC; Duty Cycles: Continuous or Intermittent. *Write today for Bulletin 526A*

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WORLD-WIDE REPRESENTATION

For more information circle **73** on inquiry card.

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PRESSURE
TRANSMITTER

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The Taber Teledyne can be an important factor in the transmission of gas and fluid pressures from distant points to central control. The Teledyne has high overload rating with exclusive features such as bonded strain gage which makes it insensitive to vibration and shock. Choice of 15 ranges (to 10,000 P.S.I.) Stainless steel pressure chamber handles corrosives. High frequency response; linear output over full pressure range. Temperature compensated for zero shift and sensitivity.

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For more information circle **74** on inquiry card.

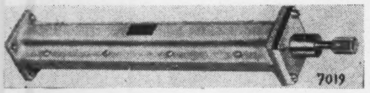
NEW INSTRUMENTS

v with sensitivities as low as 25 ohms per volt. All voltages are referred to a standard cell. Calibrator operates at 60 cps and contains a high-rejection band-pass filter so that output has less than 0.2% harmonic distortion.—*Quare Associates, Canton, Mass.*

For more information circle **225** on inquiry card.

STANDARD REFLECTIONS

New full line of Standard Reflections provides calibrated reflections or VSWR's for use in standardizing reflectometers or verifying the accuracy of slotted lines.—*Narda Corporation, Mineola, L. I., N. Y.*



For more information circle **226** on inquiry card.

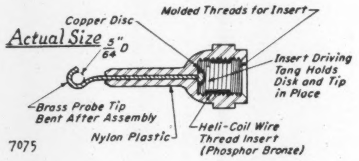
FREQUENCY FORK

New "Type 50 Miniature Precision Fork" provides frequencies of 240, 400, 500 and 1000; others on special order. Maximum operating temperature 125°C. Operates with double triode and 5 pigtail components. Base 9 prong noval; weight 3.5 oz.—*American Time Products, Inc., 580 Fifth Ave., New York 36, N. Y.*

For more information circle **227** on inquiry card.

CRO PROBE TIP

New oscilloscope probe tip incorporates several unique features of assembly as well as design. Problems of obtaining thread strength to permit tight electrical contact and resisting thread wear in relatively soft nylon body were solved by protecting nylon threads with a wire thread insert made by the Heli-Coil Corp., Danbury, Conn. A thin copper disc is held in place by the driving tang of insert. Phosphor-bronze insert forms a part of electric circuit in addition to providing strong, wear-resistant threads.—*Tektronix, Inc., P. O. Box 831, Portland 7, Ore.*

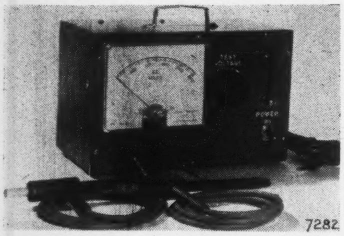

Copper Disc
Molded Threads for Insert
Actual Size $\frac{5}{64}$" D
Insert Driving Tang Holds Disk and Tip in Place
Brass Probe Tip Bent After Assembly
Nylon Plastic
Heli-Coil Wire Thread Insert (Phosphor Bronze)
7075

For more information circle **228** on inquiry card.

ELECTRICAL TESTING

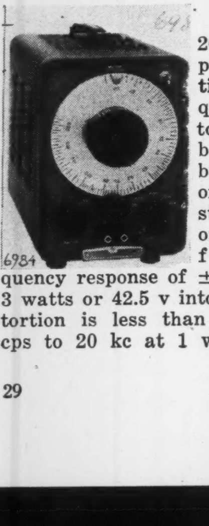
HIGH-VOLTAGE TESTER

New "Model 106" adjustable HV tester, with both light and buzzer signal on breakdowns, can be set for any test voltage between 400 and 2100 vac; has detachable test leads and retracting prods; operates from 115-vac line.—*Slaughter Co., Piqua, Ohio.*



For more information circle **229** on inquiry card.

AUDIO OSCILLATOR



New "Model 201C" features precise attenuation; covers frequencies 20 cps to 20 kc in three bands with calibration accuracy of 1%, frequency stability of 2% or 0.2 cps, and full-range frequency response of ±1 db. Output is 3 watts or 42.5 v into 600 ohms. Distortion is less than 0.5% from 50 cps to 20 kc at 1 watt output and less than 1% from 20 cps to 20 kc at 3 watts output.—*Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif.*

For more information circle **230** on inquiry card.

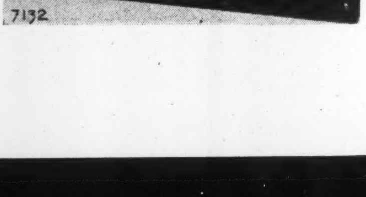
FM SIGNAL GENERATOR

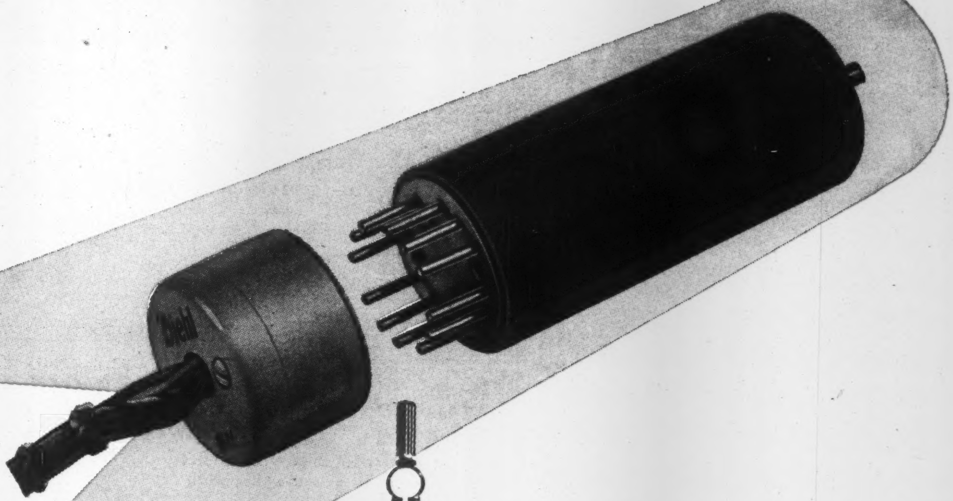
New "Model 100D," for precision testing of alignment, bandwidth and sensitivity of FM receivers, has frequency deviation accuracy better than 5% of full-scale at 1000 cps over two ranges of 0-30 kc and 0-250 kc; features extremely low drift, low modulation distortion (less than 2%), low A-M, low hum, leakage so low it cannot be measured with a 0.1-uv detector.—*New London Instrument Co., Inc., 31 Union St., New London, Conn.*

For more information circle **231** on inquiry card.

PULSE GENERATORS

New "Type 349 Pulse-Generator" for millimicrosecond pulses and "Type 351 Pulse Generator" for wider pulses are designed to cover entire range of





THIS NEW **DIEHL** SIZE 11 RESOLVER SETS A new standard of Accuracy...

. . . a new low in total functional error for a Size 11 Resolver—0.05%! An entirely new design concept permits complete machine-winding of the units, with resulting high uniformity of product and performance. Other novel design features enable the resolver to withstand altitudes of 70,000 feet without pressurization.

There are three types . . . *with high impedance*, permitting the primary to be excited with 110 volts at 400 cycles . . . *with low impedance*, when higher frequency response is desirable . . . and *compensator wound* for temperature and frequency variations.

These types are obtainable, each with 2 input and 2 output windings, in either Class I Design with 0.05% maximum total functional error or Class II Design with a maximum error of 0.10% where less accuracy is tolerable and lower cost is desired.

All resolvers are equipped with pin-type terminals. Mating plugs can be supplied for convenient connection to computer circuits.

Take a look at the Class I specifications. Note the new opportunities they offer to satisfy unusual application needs.

CLASS I SPECIFICATIONS

DIEHL NUMBERS	B11R1-1	B11R1-5	B11R1-6	REMARKS
Type	Low Impedance	High Impedance	Compensator Wound	
Total Functional Error	0.05%	0.05%	0.05%	
Input Impedance (ohms)	$750\angle 80^\circ$	$3000\angle 80^\circ$	$1500\angle 78^\circ$	±10% on ohms ±2° on angles
Effective Resistance (ohms)	3,000	12,000	5,500	when resonated
Transformation Ratio	$0.975\angle 6^\circ$	$0.975\angle 6^\circ$	$0.975\angle 6^\circ$	±0.02 on ratio ±1° on angle
Max. Null Voltage (m. v./volt input)	1.0	1.0	1.0	Quadrature
Weight (ounces)	4.7	4.7	4.7	

Patents Pending

All measured data above taken at standard test voltage of 10 volts at 400 cps. Case and shaft supplied with reference markers.

other available components

A.C. SERVOMOTORS • A.C. SERVOMOTORS WITH A.C. TACHOMETERS • A.C. SERVOMOTORS WITH D.C. TACHOMETERS
A.C. AND D.C. TACHOMETERS • D.C. SERVO SETS • RESOLVERS

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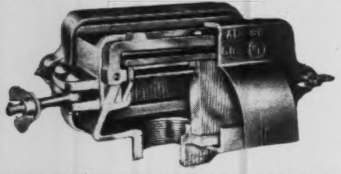
For more information circle **75** on inquiry card.

PROTECTOSEAL
FLAME ARRESTERS AT OPEN VENTS
PROTECT
HIGH FLASH POINT SOLVENTS

STORAGE TANK INSTALLATION AT EASTERN BY-PRODUCT BENZOL PLANT COMBINES

Maximum Air-Flow Capacities
Positive Fire Protection
Low-Cost Maintenance

Protectoseal Series No. 860 Non-Conservation Type Vents installed on the large, horizontal storage tanks of this By-Product Benzol Plant provide maximum air-flow consistent with operating efficiency, positive fire protection and effective low-cost maintenance.

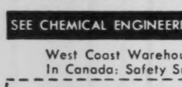


LIGHT WEIGHT, PRESSURE-TIGHT HOUSINGS
Combine ease of installation with durability. Housings meet hydrostatic pressure tests by Underwriters' Laboratories.

POSITIVE FIRE PROTECTION
Sturdy Protectoseal rectangular plate type flame arrester protects tank contents by preventing the propagation of fire and explosion into tank. Easily accessible for cleaning without disturbing original factory alignment.

LOW-COST MAINTENANCE
Modern swing-bolt design permits quick removal of vent covers and weatherhoods for visual inspection or cleaning.

VAPOR CONSERVATION TYPE VENTS



Similar in design to the Non-Conservation Vents but incorporate relief valves in the vent housing which conserve vapors to reduce costly evaporation losses. Valves retard intake of air and escape of vapors as tank normally breathes in and out.

IN-LINE VENTS

An exclusive Protectoseal design approved for installation at varying distances from open end of vent pipe. Suitable for inside tank house installations on storage or processing tanks, bleed lines, bleed tanks or other waste gas lines.

PROTECTOSEAL MANUFACTURES ALL TYPES OF FLAMMABLE LIQUID STORAGE TANK VENTING AND OPERATING EQUIPMENT.

SEE CHEMICAL ENGINEERING CATALOG, PAGE 1503

West Coast Warehouse: Los Angeles, Calif.
In Canada: Safety Supply Co., Toronto.

The Protectoseal Company,
1954 S. Western Ave., Chicago 8, Ill.

Please send me "Venting Fundamentals"

Name__________ Title__________
Company__________
Address__________
City__________ Zone_____ State_____

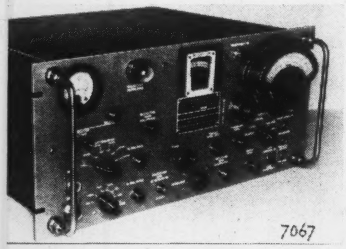
For more information circle **76** on inquiry card.

laboratory needs for rectangular pulses of varying width and amplitude. Both are said to display characteristics unprecedented in their categories. "349" has a repetition rate of 1500 pulses per second (highest yet achieved for an electromechanical pulse generator) and rise-time of less than 0.005 usec. "351" is the first general-purpose pulse generator to reach a 100-kc repetition rate; rise-time 0.018 usec and variable pulse width from 0.05 to 100 usec.—*Allen B. Du Mont Labs., Inc.*, 750 *Bloomfield Ave., Clifton, N. J.*

For more information circle **232** on inquiry card.

VLF RI-FI EQUIPMENT

New "NM-40A" radio interference and field intensity measuring equipment tunable over frequency range of 30 cps to 15 kc is commercial equivalent of Navy "AN/URM-41." It is said to be "capable of performing vital functions never before achieved by a tunable equipment covering this frequency range . . . offers many unprecedented possibilities to those engaged in the Very Low Frequency field . . . usefulness extends to research in ionospheric sounds."—*Stoddart Aircraft Radio Co., Inc.*, 6644 *Santa Monica Blvd., Hollywood* 37, *Calif.*



For more information circle **233** on inquiry card.

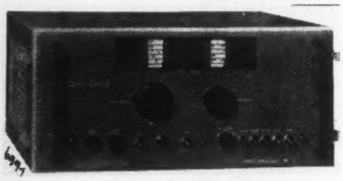
VHF RECEIVER

New "R-5200" is said to be an outstanding receiver for general communications, also usable in lab to calibrate other receivers, in flight testing, control tower, evaluating transmitters, meteor research, and intelligence work. Among features: continuous tuning, without switching, over entire frequency range of 50 to 200 Mc with unique 72" bandspread dial (accuracy 0.25%).—*Servo Corp. of America*, 20-20 *Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **234** on inquiry card.

SWEEPING OSCILLATOR

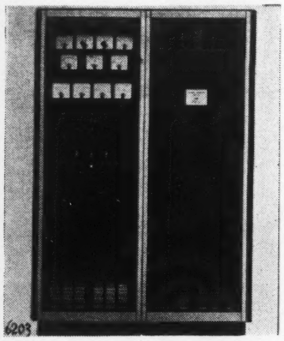
New "Vari-Sweep" all-electronic broad-band sweeping oscillator is designed for continuous coverage from 2 to 220 Mc with sweep width to 30 Mc plus, and with high output automatically held constant over frequency sweep and tuning range.—*Kay Electric Co.*, 14 *Maple Avenue, Pine Brook, N. J.*



For more information circle **235** on inquiry card.

14-KV PULSER

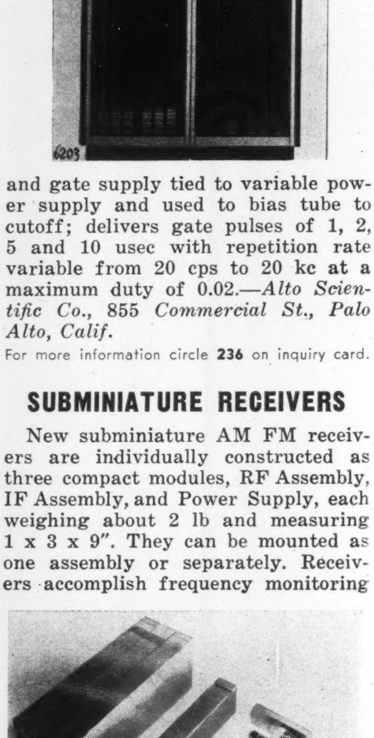
New self-contained pulser providing 15 kv at 100 ma to cathode of traveling-wave tubes features a bias and gate supply tied to variable power supply and used to bias tube to cutoff; delivers gate pulses of 1, 2, 5 and 10 usec with repetition rate variable from 20 cps to 20 kc at a maximum duty of 0.02.—*Alto Scientific Co.*, 855 *Commercial St., Palo Alto, Calif.*



For more information circle **236** on inquiry card.

SUBMINIATURE RECEIVERS

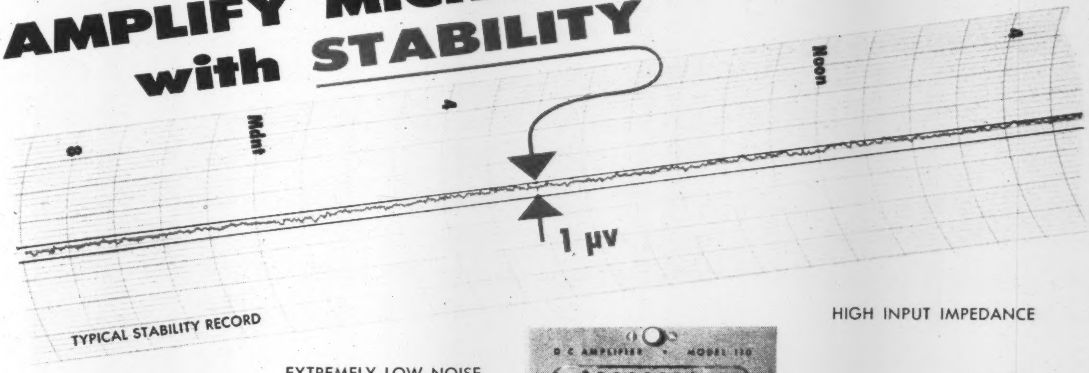
New subminiature AM FM receivers are individually constructed as three compact modules, RF Assembly, IF Assembly, and Power Supply, each weighing about 2 lb and measuring 1 x 3 x 9". They can be mounted as one assembly or separately. Receivers accomplish frequency monitoring



KAY LAB
CALIFORNIA

DC DECADE AMPLIFIER

AMPLIFY MICROVOLTS with STABILITY



TYPICAL STABILITY RECORD

EXTREMELY LOW NOISE

10 ACCURATE GAIN RANGES

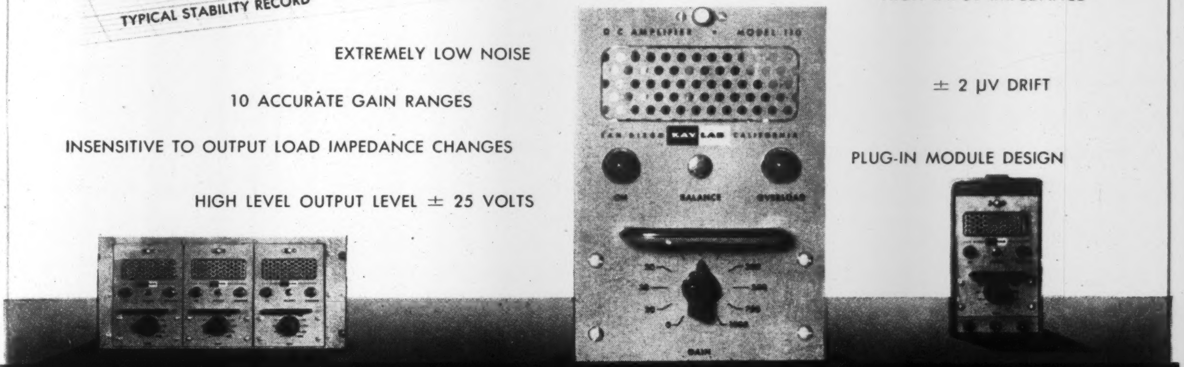
INSENSITIVE TO OUTPUT LOAD IMPEDANCE CHANGES

HIGH LEVEL OUTPUT LEVEL ± 25 VOLTS

HIGH INPUT IMPEDANCE

± 2 µV DRIFT

PLUG-IN MODULE DESIGN



The new KAY LAB Model 110 Amplifier is a low drift, high gain, chopper stabilized, broad band DC amplifier incorporating proven KAY LAB chopper amplifier circuitry. Small modular plug-in construction makes it ideally suited for group rack mounting as a part of permanent instrumentation facilities or as a general laboratory instrument in a portable cabinet. Ten precise feedback controlled gain ranges are provided. Low noise allows accurate amplification of microvolt signals. A completely new and unique output circuit provides unsurpassed linearity and dynamic performance — unaffected by output load impedance variations over a wide frequency range.

APPLICATIONS: Ideal strain-gage amplifier . . . vibration studies . . . transducer amplifier . . . scope preamplifier . . . single or multiple channel recorder driver . . . impedance matching "DC transformer" . . . general laboratory instrument wherever precise gain is required for amplification of microvolt signals.

SPECIFICATIONS

Gain	0, 20, 30, 50, 70, 100, 200, 300, 500, 700, 1000 ± 1% DC
Input Impedance	100,000 Ω
Frequency Response	± 3% DC to 10 kc, less than 3 db down at 30 kc
Phase Shift	Less than 5° to 2 kc
Equivalent Input Drift (over 40-hour period)	± 2 µv when used with regulated line voltage ± 10% change in AC input causes less than ± 5 µv change after 10-minute warm-up
Equivalent Input Noise	0 to 3 cps, less than 5 µv peak to peak 0 to 750 cps, less than 5 µv RMS 0 to 50 kc, less than 12 µv RMS
Chopper Intermodulation	Less than 0.1%
Linearity	Better than 0.1% to 2 kc
Output Impedance	Less than 1 Ω in series with 25 µh
Output Capability DC	0 to ± 25 volts with load impedance greater than 1000 Ω 0 to ± 25 ma with load impedance from 10 to 1000 Ω

POWER REQUIRED		0.9 watt each unit plus 0.6 watt each adaptor
Dimensions:	Amplifier unit	5" wide, 7¼" high, 14¼" deep
	Unit in cabinet	6" wide, 9⅞" high, 18⅜" deep
	Rack adaptor for 3 units	19" wide, 8¾" high, 18¼" deep
Net Weight		15 lbs.
Shipping Weight		30 lbs.

PRICE:	Amplifier Unit	$500.00
	Cabinet (with fan and connector)	50.00
	Rack Adaptor (with fans & connectors)	150.00

Kay Lab reserves the right to change specifications and prices without notice.

. . . the Standard in chopper-stabilized instruments

KAY LAB

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5725 KEARNEY VILLA ROAD • SAN DIEGO 12, CALIFORNIA • BROWNING 7-6700

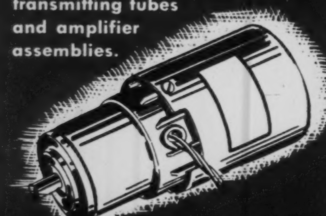
For more information circle **77** on inquiry card.

champion...

...of the lightweights

The IMC catalog features a full roster of champions, each a winner in its own right—winner by design engineer's choice on the basis of light weight, compactness and performance.

The IMC line of AC and DC subfractional, servo and gear motors, fans, blowers and dynamotors did not develop by chance. Instead, individual units were evolved and produced in direct response to the design engineer's needs. Now, many of IMC's motor-fan-blower devices are specifically requested for use in cooling of transmitting tubes and amplifier assemblies.



The entire IMC motor line, ranging from 1/1000 to 1/10 hp, presents the broadest possible range of design application. In many of the gear units, actuating devices for control problems can be incorporated on request. IMC has a motor to suit your own particular needs. We look forward to helping you.

Induction Motors Corp.

570 Main St., Westbury, L. I., N. Y.
EDgewood 4-7070

For more information circle **78** on inquiry card.

of transmitted intelligence, i.e. timing, control, voice, special instrumentation. Available in several frequency ranges from 40 to 235 Mc, new receivers feature crystal frequency control, wide band frequency response, excellent sensitivity, quieting and noise rejection.—*Land-Air, Inc., Oakland International Airport, Oakland, Calif.*

For more information circle **237** on inquiry card.

MULTI-CIRCUIT TESTER

New "Fault Locator" prevents breakdown of complicated electrical and electronic equipment; uses no vacuum tubes; not only locates points of breakdown but finds these points before components fail or act erratically. Essentially, it sets up a comparison circuit for checking against operating equipment. When any circuit varies from set standard, it signals user. All operation is completely automatic. It checks voltages, current and waveforms, at as many as 128 points in ten seconds. Physical construction depends on application. For instance, system can be made completely portable for checking aircraft equipment. It can be made an integral part of automatic machinery or can be physically separated. It must be specially designed for each application.—*Commonwealth Engineering Co., Dayton, Ohio.*

For more information circle **238** on inquiry card.

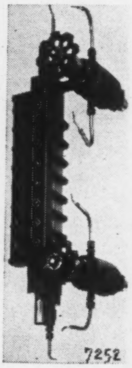
FLOW-RATE, LEVEL, WEIGHING

FLOW-RATE TRANSMITTER

New advanced version of "Mark V Flow Transducer" provides bidirectional flow measurement in any range from 0.2 to 125 gpm (10-1 range limitation on any single transmitter). Like standard unidirectional unit, it is constructed of stainless steel, has no bearings or moving seals. Accuracy 0.5%. Electrical output can be fed to indicators, recorders, controllers, or telemetering systems. Available in ½", ¾" and 1" AN sizes. Special sizes to order.—*Ramapo Engineering Co.*, 1 *Dey Lane, Riverdale, N. J.*

For more information circle **239** on inquiry card.

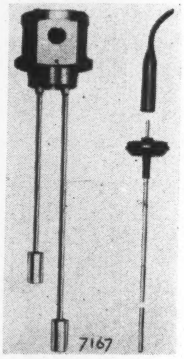
ELECTRICALLY-HEATED LIQUID-LEVEL GAGE



New electrically-heated unit is advantageous where no steam is available, where one must heat cold liquids such as waxes to get true readings; also where there is need for close control of temperatures in gage glass. Gages are available in double-chamber reflex or external-tube transparent gage models in various sizes and pressure groups; any material required to meet corrosive conditions; also explosion-proof units.—*Jerguson Gage & Valve Co.*, 80 *Fellsway, Somerville* 45, *Mass.*

For more information circle **240** on inquiry card.

LIQUID-LEVEL PROBES

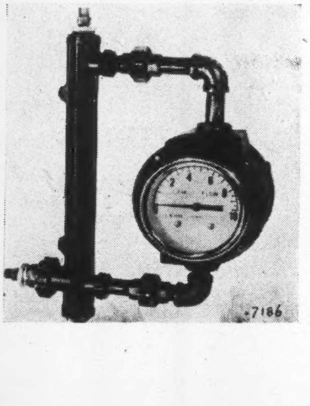


New line of liquid-level probe assemblies is said to be complete. Examples: (1) "MEK-3048-A Double Electrode Probe Assembly" incorporates special electrodes made with alumina insulation used in jet engines; conducting portions are made of corrosion-resistant stainless steel. Weather-resistant enclosure can be supplied in bronze, cast iron, or stainless steel. (2) "MEK- 3045-A Single Electrode Probe Assembly" for dairy and food processing will fit a standard IAMD union ferrule and hex nut assembly. Many other special probe assemblies are offered.—*Machinery Electrification, Inc., Northboro, Mass.*

For more information circle **241** on inquiry card.

VANE-TYPE FLOWMETER

New "No. 1050" simply-designed vane-type flowmeter for air or gas flow features constant pressure drop can be used for indicating, controlling, signal alarm, safety shutoff, sequence starting or shutdown, etc. Readable



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Exacting TI production line methods have now been applied to the widely known Burlington instruments . . . to give you the TI-BURLINGTON LINE of ac and dc ammeters and voltmeters in a wide range of styles, shapes, and sizes . . . economical panel instruments with permanent precision . . . in greater quantity and on earlier delivery than ever before.

TI-BURLINGTON direct current instruments use a permanent Alnico V magnet moving coil meter movement with high torque-to-weight ratio for minimum error and unvarying response. TI-BURLINGTON alternating current instruments use an iron repulsion vane meter movement with Alnico V damping magnets plus a special aluminum alloy damping vane for accuracy in all commercial frequencies.

Long service life is assured by careful design and manufacture. Texas Instruments plant atmosphere is air conditioned for cleanliness, temperature, and humidity. Cadmium-Cronak plating protects the component parts from corrosion. Rigid 100% inspection includes microscopic examination of pivots, jeweled bearings, and hair springs.

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6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle **79** on inquiry card.

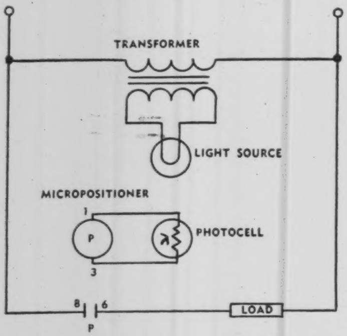
BARBER COLMAN

ultra-sensitive relays

HELPFUL DATA FOR YOUR CIRCUITRY IDEA FILE . . .

(No. 1 in a series by Barber-Colman Company)

The circuit drawing below indicates just one of the hundreds of ways many manufacturers are utilizing Barber-Colman Micropositioner ultra-sensitive relays to solve complex control problems. Could this be the answer to some of yours, too?



PHOTOELECTRICITY APPLICATION

Many stages of electronic amplification in photoelectric controls can be completely eliminated with a Barber-Colman Micropositioner, since a current generating photocell alone provides sufficient power to operate this relay directly.

A Micropositioner operating on 50 microwatt input (with fine silver contacts rated at 1 ampere, 110 volt 60 cycle, resistive load) *is essentially a tubeless amplifier capable of two million times amplification.*

Among the many applications for this simplified, *non-electronic* photocell control are: punch press safety controls . . . emergency lighting controls . . . door openers . . . burglar alarms . . . level controls . . . packaging, sorting, filling, and materials handling controls . . . plus many other automation functions.

If you are developing an application calling for photocell control, why not make a test with a Micropositioner designed for circuits similar to that shown above? Write for technical bulletins F7279 and F3961-5.

BARBER-COLMAN MICROPOSITIONER POLARIZED DC RELAYS

Various types...plug-in, solder-lug, screw terminal, hermetically sealed. Operate on input powers of 50 to 1,000 microwatts for use in photoelectric circuits, resistance bridge circuits, and electronic plate circuits. Send for data.

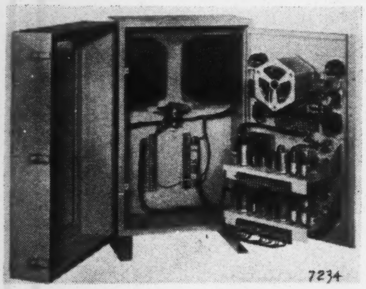
Barber-Colman Company
Dept. F, 1415 Rock Street, Rockford, Illinois

For more information circle **80** on inquiry card.

accuracy 0.5%; calibrated accuracy 2% to 5% depending on scale range and diameter. For scale ranges up to 50 cfm, all the gas passes through meter making it practically independent of pipe restrictions and elbows. Scale ranges over 50 cfm are connected in shunt.—*Scully-Jones & Co., 1901 S. Rockwell St., Chicago 8, Ill.*

For more information circle **242** on inquiry card.

HEIGHT-OF-FILL MONITOR

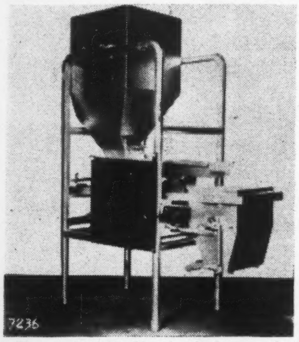


7234

New improved model of "Hytafill" features (1) built-in test panel for speedy adjustment of electronic circuits; (2) hinged-door accessibility to internal mechanism; (3) integral totalizing counters for recording under- and over-fills; (4) line-voltage stabilizer.—*X-Ray Dep't, General Electric Co., 4855 Electric Ave., Milwaukee 1, Wis.*

For more information circle **243** on inquiry card.

WEIGHER-FEEDER



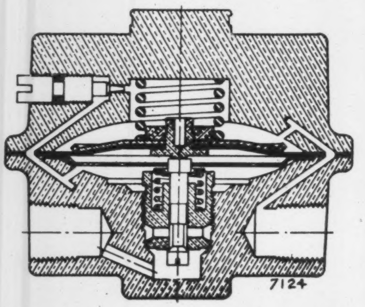
7236

New model of "Heavi-Weigh," for dry materials, automatically feeds predetermined weights between limits of 5 lb and 100 lb, into bags, boxes, molds, etc.; can serve dependably as one of a series of automatic and synchronized machines (in a "manless factory") or as a simple can-filler.—*Glengarry Processes, Inc., Bay Shore, N. Y.*

For more information circle **244** on inquiry card.

PRESSURE, VACUUM, PNEUMATICS, etc.

DIFFERENTIAL REGULATOR

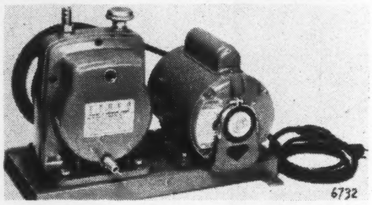


7124

New "Model H-21F" differential pressure regulator with integral needle valve is for economical purging with air, water, or gas, in services where flow-rate measurement is unnecessary. It can also be supplied in combination with a small flow-rate indicator as a complete inexpensive purge meter package. Ranges from 0.2 to 2.0 scfh of air and 20 to 200 cc/min of water are available.—*Conoflow Corp., 2100 Arch Street, Philadelphia 3, Pa.*

For more information circle **245** on inquiry card.

HIGH-VACUUM PUMP



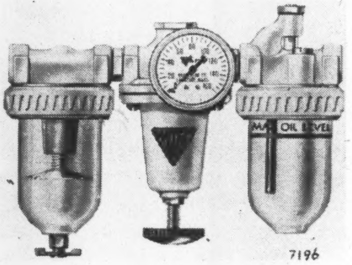
6732

New "Hyvac 2" delivers a free air displacement of 20 liters per minute (twice that of "Hyvac"), is practically vibrationless and noiseless; can pump from atmospheric to ultimate pressure in about 5 minutes; delivers a guaranteed ultimate vacuum of 0.1 microm. Six available motor arrangements include explosion-proof and 3-phase.—*Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.*

For more information circle **246** on inquiry card.

AIR FILTERS, REGULATORS, LUBRICATORS & COMBINATIONS

New line of filters, lubricators, and combinations (filter-regulator-lubricator) is complete. Air filters with transparent bowl for air pressures up to 150 psi and temperatures up to 120°F; with metal bowl for pressures



7196

up to 250 psi. Lubricators add controlled oil fog. Twenty different combination units.—*Watts Regulator Co., Lawrence, Mass.*

For more information circle **247** on inquiry card.

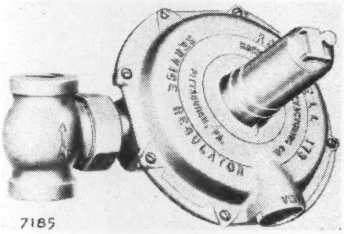
AIR FILTER, REGULATOR AND LUBRICATOR

New "Air Control Assembly" automatically filters, regulates and lubricates compressed air used in operation of pneumatic equipment. Automatic drain trap collects moisture from filter: No periodic draining maintenance. After cleaned air is regulated to desired pressure, lubricator adds fine oil mist.—*Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.*

For more information circle **248** on inquiry card.

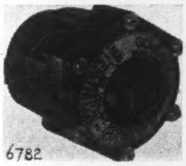
GAS REGULATOR

Newly redesigned "173" service regulator features increased versatility and additional savings in shipping and handling costs; has new weather-resistant aluminum diaphragm case; is particularly useful for pilot-loading systems with outlet pressures of less than 1 lb.—*Meter and Valve Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.*



For more information circle **249** on inquiry card.

AIR VOLUME BOOSTER



New "Governaire Series 4500" with ⅝" diameter supply and exhaust seats features maximal flow capacity, even at low pressure differentials. Flow capacity 115 cfm when signal pressure is 10 psi and supply pressure is 50 psi. With 150-psi supply, capacity is 170 cfm. Unit can handle supply pressures up to 250 psi, signal or output pressures to 150 psi.—*Governaire Div., Bellofram Corp., Burlington, Mass.*

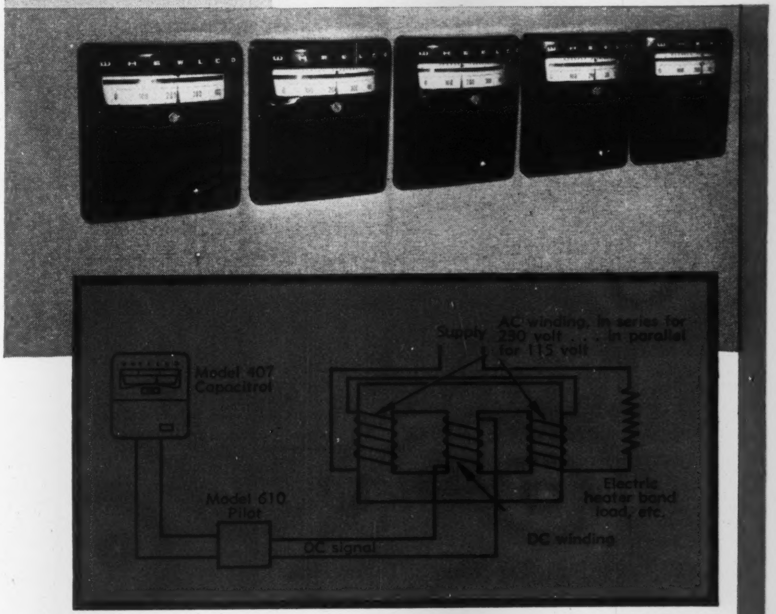
For more information circle **250** on inquiry card.

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

Stop wear and tear!
Get closer control
Of electric furnaces
With Model 407 Capacitrol


Supply
AC winding, in series for 230 volt . . . in parallel for 115 volt
Model 407 Capacitrol
Model 610 Pilot
DC signal
Electric heater band load, etc.
DC winding

Accurate, stepless control with remarkable freedom from service problems convinced Metals and Controls Corp., Attleboro, Mass., that Model 407 Capacitrols offered the best control for the calibrating equipment which gives Klixon Inherent Overheat Motor Protectors their outstanding precision.

Smooth, stepless proportioning is characteristic of the Model 407, because it uses saturable core reactor to vary input of electric heating elements in accordance with system demands. When an application demands exact temperature control with minimum downtime or maintenance—your best possible choice is the Model 407! Call your Wheelco field engineer today and let him analyze your heating problems.

WHEELCO INSTRUMENTS DIVISION

Barber-Colman Company

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Industrial Instruments • Automatic Controls • Air Distribution Products
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For more information circle **81** on inquiry card.

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TO BETTER WIRING

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Confidence...
Less
Expense
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Taper Technique

A-MP Taper Pins, Taper Bloks, Taper Tips, Taper Tabs and Taper Tab Receptacles offer great freedom of circuit design and insure maximum electrical stability.

They cut material cost . . . cut labor cost . . . and reduce assembly time. Taper Technique is benefiting manufacturers of business machines, aircraft, guided missiles and electronic equipment.

You, too, can benefit by the A-MP Taper Technique. Consult your local A-MP salesman or write to Harrisburg.

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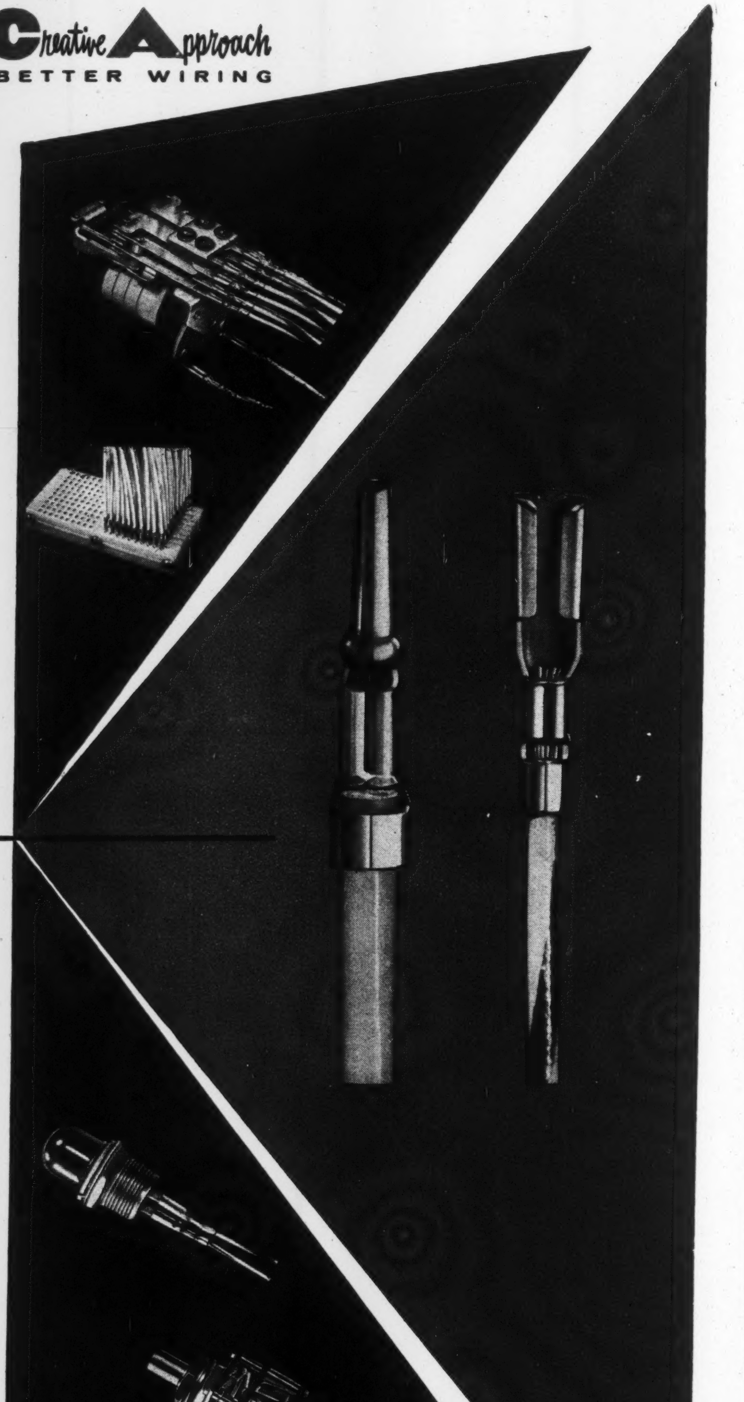
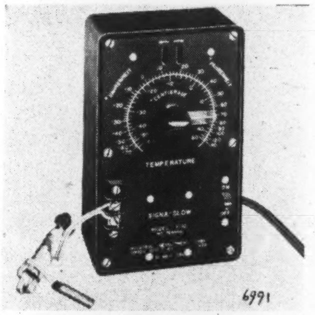
For more information circle 82 on inquiry card.



TEMPERATURE

THERMISTOR BRIDGE

New "Model T-10 Temperature Measuring Bridge" covers range of –60°C to 60°C (–70°F to 140°F)

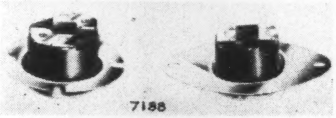


vith an easy-to-read 2-color scale over " long and calibrated in both C and '. Primary element is thermistor ype. Instrument's feature is new 'Signa-Glow Null Indicator" comprising a pair of miniature glow amps which show, at a glance, degree and direction of unbalance.—*ndustrial Development Labs., Inc., 7Pollock Ave., Jersey City* 5, *N. J.*

r more information circle **251** on inquiry card.

APPLIANCE THERMOSTAT

New "202 Series Klixon" fixed-etting low-cost snap-action tempera-ure controls feature improved per-



formance and extensive application ises; temperature settings from -10°F to 350°F. Electrical ratings: ½ hp or 25 amp non-inductive load.—*Spencer Thermostat Div. Metals & Controls Corp. Attleboro, Mass.*

r more information circle **252** on inquiry card.

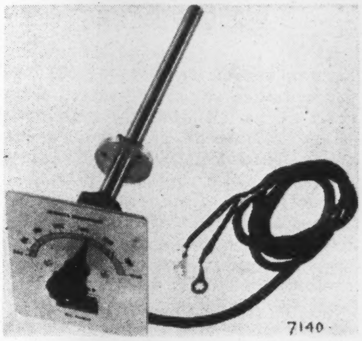
THERMISTOR KIT

New "No. 100 see-easy" kit of twelve standard thermistors in a plastic compartment case, for reference by engineers, designers and technicians, includes specification sheets covering dimensions, electrical characteristics and temperature-resistance relationships of rod-type thermistors, also thermistor applications in electrical and electronic measurement and control devices. Thermistors cover resistance ranges from 25 to 1,000,000 ohms.—*Friez Instrument Div., Bendix Aviation Corp., Baltimore, Md.*

For more information circle **253** on inquiry card.

ROD THERMOSTAT

New "Temp-Gard" adjustable high-temperature thermostat has two ranges: one from 600 to 900°F; the other (for special applications) from 600 to 2400°F. It can be used for heat holding or as an automatic shut-off device when connected to a relay. A low-cost pyrometer can be incorporated if desired. Primary element comprises an outer Inconel tube and an enclosed porcelain rod; operates plunger of a Microswitch.—*Dep't 5D, The Franklin Dales Co.,* 180 *East Mill St., Akron, Ohio.*

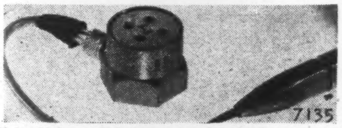


For more information circle **254** on inquiry card.

ACCELERATION

ACCELERATION PICKUP

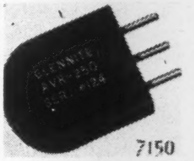
New "Model 2214 High G Accelerometer," for use in measurement of hock phenomena, is claimed to exhibit "the ultimate in high-frequency esponse, low mass, and large output." s 70-kc natural frequency permits ibration measurement with linear esponse up to at least 14,000 cps. Iass is 0.35 oz. High output (3 mv/) is linear up to 30,000 *G.—Endevco orp.,* 161 *E. California St., Pasaena, Calif.*



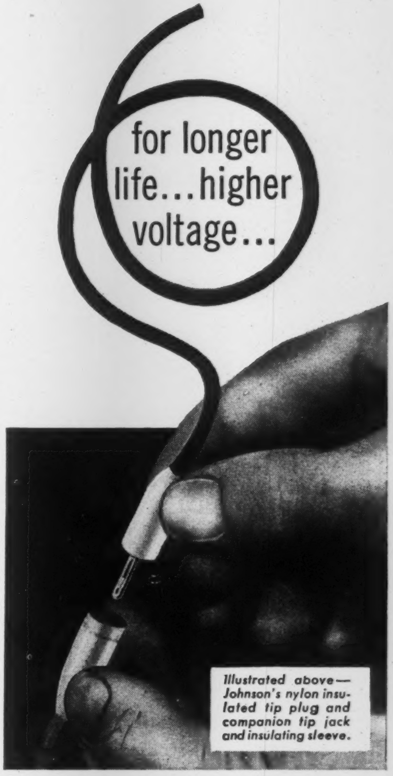
r more information circle **255** on inquiry card.

ACCELERATION PICKUPS

New "Glennite AVR-250" subminiature variable-reluctance acceleration pickups, for measurement of low-frequency vibrations and accelerations on structures too small to accommodate conventional pickups, are made under exclusive license from Boeing Airplane Co.; have exceptionally small volume of less than 0.09 cu in; can measure sustained accelerations up to about 300 cps; are for use with standard carrier systems.—*Gulton Mfg. Corp., Metuchen, N. J.*



For more information circle **256** on inquiry card.



Illustrated above—Johnson's nylon insulated tip plug and companion tip jack and insulating sleeve.

Solderless Nylon Connectors

(Available in 11 bright colors)

- Shock-proof nylon sleeves—won't chip or crack with the hardest usage.
- Excellent for high voltage applications.
- Highly resistant to extremes of heat, cold and moisture.
- Tip and banana plugs designed for simplified solderless connection of up to 16 gauge stranded wire.
- Economical—simple, functional design gives you top quality at low cost.

SPECIFICATIONS

BANANA PLUG—Nickel-plated brass construction with nickel-silver springs. Spring plug is .175" diameter, fits all standard banana jacks.

TIP PLUG—Recessed metal head is fully insulated. Metal parts are brass, nickel-plated. Pin is .081" diameter—fits all standard tip jacks.

NYLON TIP JACK AND INSULATING SLEEVE—Complete assembly includes standard nylon tip jack with threaded nylon insulating sleeve. Ideal for patch cords or for panel mounting where an insulated rear connection is desired.

Write for samples, prices and further information.

Pilot Lights

Available in a wide variety of types, Johnson Pilot Lights are stocked by parts distributors throughout the country. Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass and lucite jewels in clear, red, green, amber, blue, or opal lenses. Specials, including those meeting military specifications are also available in production quantities. For full information, write to:

E. F. Johnson Company

2708 SECOND AVE. S.W. • WASECA, MINN.

For more information circle **83** on inquiry card.

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An Introduction to
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by A. J. YOUNG
Head of Central Instrument Laboratory, Imperial Chemical Industries Ltd.

A clear and thorough treatment of the practical aspects of automation—the application of the instrument to the process. Covers: plant controllability; measuring and transfer lags; controller operation; valve characteristics; and disturbance effects. Includes many examples. 380 pages + XVIII, cloth 5¾" x 8¾"

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ABSORBANCE ACCESSORY FOR SPECTROPHOTOMETER

New linear absorbance accessory for "Model 21" infrared spectrophotometer permits direct recording of linear absorbance over full range 0 to 1.0 absorbance unit; has two simple interchangeable gear systems. When user selects linear gearing, instrument provides spectra recorded in percent transmittance; when logarithmic gearing is used, linear absorbance recordings are obtained; records give a true picture of correlation between band intensity and chemical structure; eliminate tedious computations required to convert transmittance to absorbance for quantitative analyses.—*Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **257** on inquiry card.

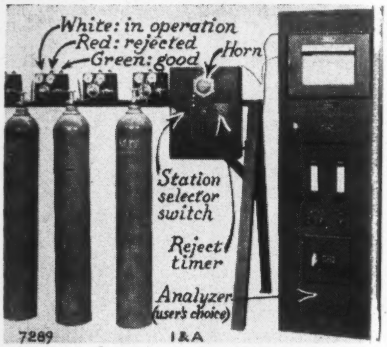
H$_2$S DETECTORS

New improved model of maker's hand-operated detecting instrument for hydrogen sulphide features a dual scale to provide accurate readings in % by volume or in grains per 100 cu ft, extending use of instrument to gas utilities and gas distribution firms. Range of standard instrument is zero to 25 grains per 100 cu ft; % graduations on scale are for detecting and accurately measuring H_2S in atmosphere around working locations. ★ New "Supersensitive Hydrogen Sulphide Detector" has dual scale with ranges from 0 to 50 ppm by volume and from 0 to 3 g/100 ft^3.—*Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.*

For more information circle **258** on inquiry card.

AUTOMATIC CYLINDER SAMPLER FOR COMPRESSED GASES

New automatic cylinder sampling system assures correctness of acceptances and rejections. Operator loads up rack and presses start button: sequence starts with solenoid valve purging the line for No. 1 cylinder. After 3 minutes, No. 2 cylinder is purged and No. 1 cylinder is analyzed This takes 45 seconds and result i shown visibly (also audibly if cylinde is below standard). System automatically advances from each cylinder t the next.—*Thermco Labs., Johnso Rd., Michigan City, Indiana.*

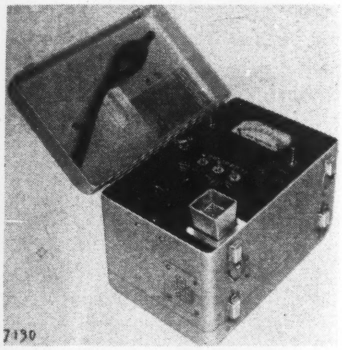


7289

For more information circle **259** on inquiry card

ODORANT MEASURER

New "Odortester" is a battery-operated instrument for quantitativ determination of odorant in natura and liquid propane gases. It register directly in terms of percent gas b volume; operates on same principl (and uses same Wheatstone Bridg filaments) as maker's "Vapotester." —*Davis Instruments, Inc., 45 Hallec St., Newark, N. J.*



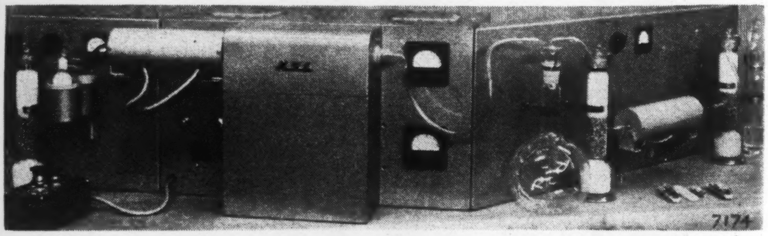
7130

For more information circle **260** on inquiry car

HYDROGEN AND CARBON ANALYZER

New gas analyzer, for analysis of H and C in Ti, Zr, and heat-resisting alloys of Fe, Co and Ni (also other metals and hydrides), utilizes high-frequency furnace, features minimal time per determination.—*Nationa Spectrographic Laboratories, Inc 6300 Euclid Avenue, Cleveland 3 Ohio.*

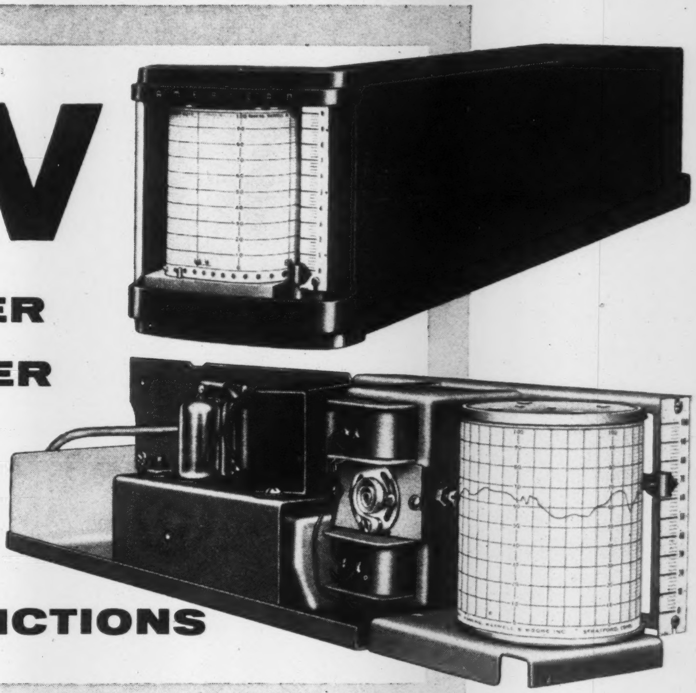
For more information circle **261** on inquiry car



7174

NEW

MICROAMMETER
MILLIVOLTMETER
RECORDER
PERFORMS 6
ESSENTIAL FUNCTIONS



- ★ **Measures low-level dc signals with calibration accuracy within 0.5%, and sensitivity within 0.2% of span.**
- ★ **Records on 3" continuous strip chart or IBM-type card chart, with linear coordinates.**
- ★ **Positions recording pen with force many thousand times greater than usual direct-deflection electrical movements.**
- ★ **Operates on force-balance principle compensating for ambient conditions, changes in power supply and components.**
- ★ **Gives high-speed recording — up to 0.05 seconds for 63% of fullscale changes.**
- ★ **Provides span and zero adjustments for ease of calibration and zero suppression in the field, without special equipment.**

The new 'American-Microsen' Series 130 Recorder is a highly sensitive microammeter or millivoltmeter that gives positive, accurate electrical measurement and rugged, maintenance-free service. Yet the unit costs less than other recorders for the same purpose.

Heart of the Series 130 Recorder is the "Microsen" balance that converts low-level dc input signals into powerful output current to drive the recording pen. Pen position is fed back to the input. Consequently, the recording unit is force-balanced in precise relationship with the input signal. Power is ample to operate alarm contacts, which are available.

SPECIFICATIONS

POWER SUPPLY: 115 volts, 60 cycles. **POWER REQUIREMENT:** 9 watts.

INPUT RANGES: Voltage – 0-20 millivolts to 0-100 volts dc. **Current** – 0-200 microamperes to 0-100 milliamperes dc. **Input Sensitivity** – 6700 ohms per volt.

ACCURACY: ± 0.5% of span. **SENSITIVITY:** ± 0.2% of span. **REPEATABILITY:** ± 0.25% of span.

EFFECT OF SUPPLY VOLTAGE: Less than 0.5% error 90-130 volts.

EFFECT OF AMBIENT TEMPERATURE: Less than 0.5% error 50° to 100° F., and less than 1% to 130° F.

RESPONSE TIME: Fast Speed – 0.2 seconds standard for 63% of fullscale input change; up to 0.05 seconds for 63% on special order. **Slow Speed** – approximately 4 times fast speed setting.

SHOCK RESISTANCE: Withstands shock up to 30 times gravity.

CHART SPEEDS: Strip Chart – 1" per hr., standard; 3" or 6" per hr. available. **Card Chart** – 1 rotation per day, standard.

SPAN ADJUSTMENT: ± 10% of span. **ZERO ADJUSTMENT:** ± 100% of span.

PRICE: $250.00 consumer net for standard models.

Write for Bulletin MG10

MANNING, MAXWELL & MOORE, INC.

MAXWELL
MANNING M&M & MOORE INC.
TRADE MARK

INDUSTRIAL CONTROLS DIVISION, STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC TRANSMITTERS, INDICATORS, RECORDERS, CONTROLLERS, ELECTRO-PNEUMATIC VALVE POSITIONERS AND ELECTRO-HYDRAULIC CONTROL VALVE OPERATORS.

For more information circle **85** on inquiry card.

Continuous Automatic
BATCH COUNTING

Instantaneous Reset
Counts batches continuously without slow down and without missing a single count between batches.

Automatic Batch Control
Operates automatically to close chutes, operate diverter, start or stop conveyor, machine, etc.

Electric Actuation
May be located remote from the source of actuation (switch, relay, photoelectric unit or other circuit breaking device).

Models to fit the job
Full range selection; permits quick setting for any batch quantity within the range of the counter (ranges to 10,000).

Limited selection; permits quick setting to certain batch quantities for which the counter is built.

Wide Choice of Features
Warning or preliminary control, built-in totalizing counters, remote starting and stopping, and many others.

Send for literature
with application case histories or tell us about your requirements.

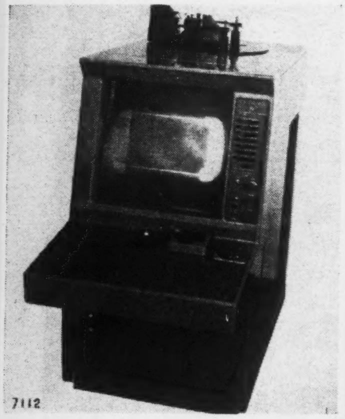
PIC
PRODUCTION INSTRUMENT CO
702 W. Jackson Chicago 6, Illinois

For more information circle **86** on inquiry card.

COMPUTING and DATA PROCESSING

BALLISTIC FILM ANALYZER AND RECORDER

New "Boscar E, J, and N Series" machines, for analysis of film records such as high-speed motion photography, etc., combine both optical and measuring systems and have interchangeable film movements to handle five types of films. Various measurement and output systems are available giving analog or digital output from either a stick flying-spot control or a spheroid cross-wire control.—*Benson-Lehner Corp., 11930 W. Olympic Blvd., Los Angeles 64, Calif.*



For more information circle **262** on inquiry card.

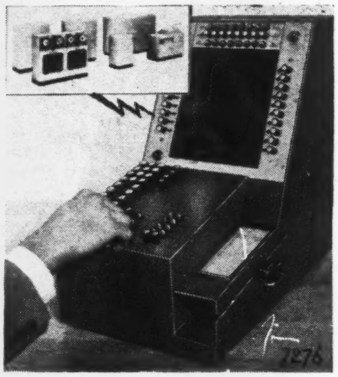
CASH REGISTER SYSTEM

New low-cost system, said to "represent a revolutionary change in department store cash register systems," can effect savings of "80% in equipment investments, 50% in maintenance and 20% in data processing"; is described also as "a building block for future data processing systems using automation and electronic methods."—*Clary Multiplier Corp., 408 Junipero St., San Gabriel, Calif.*

For more information circle **263** on inquiry card.

AIR RESERVATION SYSTEM

New "Univac Airlines Reservation System" controls passenger reservations automatically, by storing, adjusting and reporting all space and related data almost instantaneously; is adaptable to rail and bus transportation, as well as to other reservation functions. System combines a centrally located master unit linked either directly or by communications lines—depending upon distance—to small "agent" sets in each reservations or ticket office. These sets are simple in design and require no special training for operation. Once initial flight information has been determined, agent addresses an "inquiry" to system's master control by means of punch keys on his set. An almost instantaneous reply is received showing space availability and flight information. System can transmit facts on as many as eighty flight legs in a single reply. —*Remington Rand Univac Div., Sperry Rand Corp., 1902 W. Minnehaha Ave., St. Paul W4, Minn.*



For more information circle **264** on inquiry card.

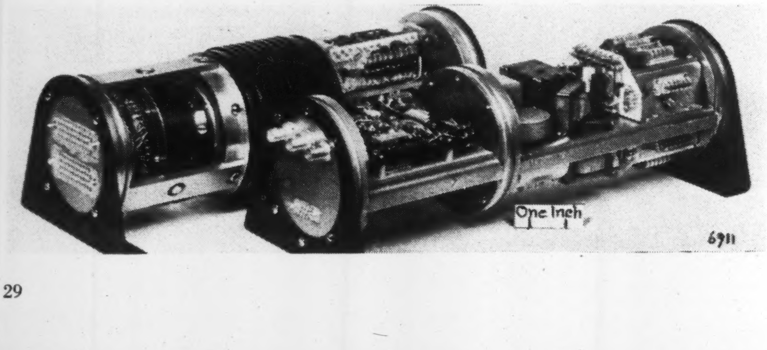
COMPUTER POWER SUPPLY

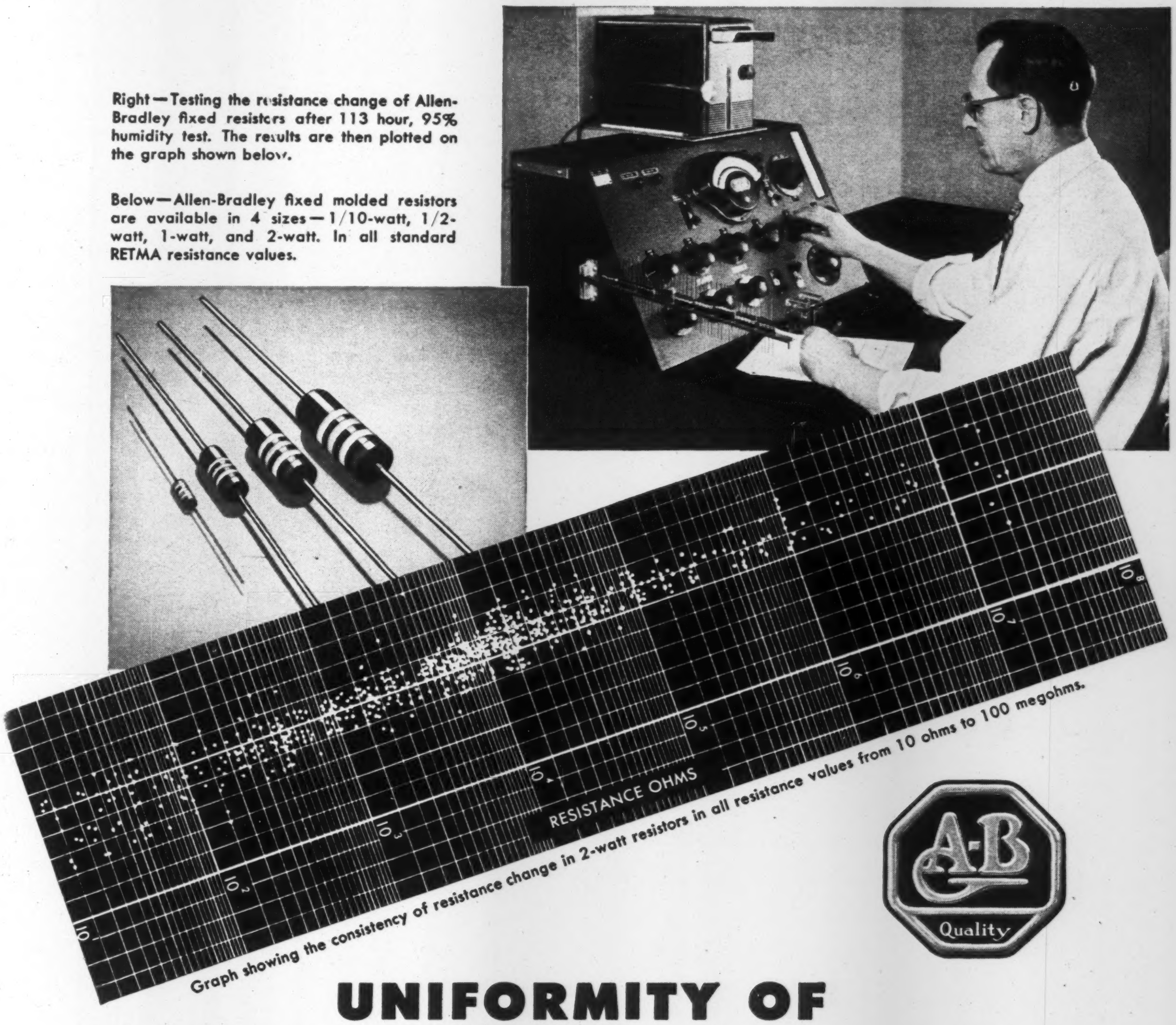
New special "Stablvolt" dual magnetic regulated supply provides line-transient-free precision regulated

LOW-LEVEL MULTICODERS

New units operating collectively as a low-level pulse-width multicoder are designed for flight-test instrumentation conditions; accept output voltage signals in low-millivolt range from 43 or 88 pickups or reference sources, sample these signals in time sequence, code data samples in pulse width form, and provide an output of pulse-width signals for operating airborne tape recorders, etc.—*Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.*

For more information circle **265** on inquiry card.





Right—Testing the resistance change of Allen-Bradley fixed resistors after 113 hour, 95% humidity test. The results are then plotted on the graph shown below.

Below—Allen-Bradley fixed molded resistors are available in 4 sizes—1/10-watt, 1/2-watt, 1-watt, and 2-watt. In all standard RETMA resistance values.

Graph showing the consistency of resistance change in 2-watt resistors in all resistance values from 10 ohms to 100 megohms.

UNIFORMITY OF ALLEN-BRADLEY RESISTORS IS THE KEYNOTE OF THEIR QUALITY

Allen-Bradley resistors have the greatest *uniformity* in mechanical size, shape, and electrical characteristics of any electronic component manufactured.

As a function of Quality Control, Allen-Bradley continuously samples its resistor production, running tests on each characteristic to verify *uniformity* and *consistency* of the production.

Graph shows production sampling of over 100 million resistors showing the small deviation in the resistance change characteristic in a humidity test conducted at 95%, 55°C for 113 hours. Such a *phenominally low deviation* over such a *large quantity of production* is the reason that Allen-Bradley fixed resistors are the *standard* of the electronic industry—where quality counts!

Allen-Bradley Co., 140 W. Greenfield Ave.
Milwaukee 4, Wis.

In Canada—
Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

For more information circle **87** on inquiry card.

case history:

ANDEROL LUBRICATION solves HIGH TEMPERATURE PROBLEM for Bausch & Lomb

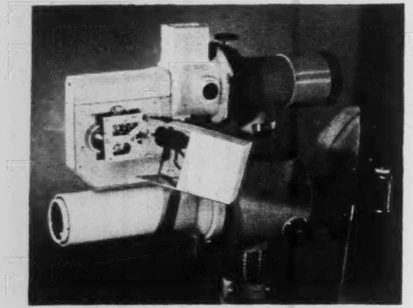


Photo courtesy Bausch & Lomb Optical Company

The Bausch and Lomb Optical Company employs Anderol synthetic oil for the lubrication of timing mechanisms and gears subjected to extremely high temperatures. Anderol not only satisfies this requirement . . . but also provides long-term usage, stability and protection. Other advantages include lower maintenance costs, uniformity of performance and improved customer relations through greater reliability of the product.

Combination of Advantages

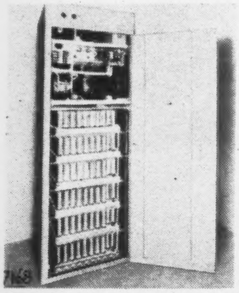
Anderol products can and do combine many advantages and applications into a single lubricant. Our laboratory services are available to *you*. Send us your lubrication problem, for samples and recommendations. In any quantity, large or small, Anderol "custom-made" lubricants can help improve your product, and its performance.

WRITE TODAY for a list of products, samples and complete data, Dept. 6.

ANDEROL
SYNTHETIC LUBRICANTS
Lehigh Chemical Company
CHESTERTOWN, MARYLAND

For more information circle **68** on inquiry card.

direct voltage for analog and digital computers where very low ripple and excellent dynamic and static regulation are required. Dual magnetic regulation system is said to eliminate many "faults basic to the ordinary magnetic amplifier voltage systems." First regulator is of internal reference type and regulates line transients and line voltage change. Second regulator regulates against load change and is of null seeking type. Instantaneous magnetic line voltage regulator keeps line voltage constant. —*Magnetic Research Corp.*, 200 *Center St., El Segundo, Calif.*



7168

For more information circle **266** on inquiry card.

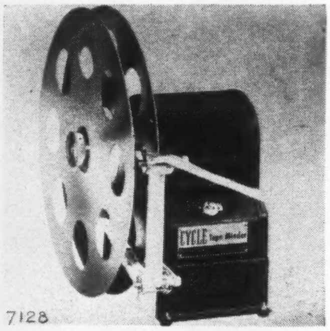
LF NOISE GENERATOR

New "Low Frequency Noise Generator" is designed specifically for use with dc analog computers: air turbulence, radar noise, vibration and other noise interferences can be simulated by injection of filtered random signals. Output is a rectangular waveform of constant amplitude and random width, easily filtered to provide a wide variety of power spectra and amplitude distributions. A radioactive sample and Geiger-Mueller counter constitute primary source of random pulses. These trigger a bistable multivibrator to generate nearly-rectangular wave-forms. Amplification and limiting of multivibrator output produces desired output wave-form. Amplitude limiting is nominally ± 100 v, depending precisely on value of computer reference voltage.—*J. B. Rea*, 1723 *Cloverfield Blvd., Santa Monica, Calif.*

For more information circle **267** on inquiry card.

TAPE WINDER

New "Universal Model Tape-Minder" to supplement "Standard Model" for communications and business-machines industry will find wide application to a variety of tape-producing, equipment: teletype, ticker, automatic typewriter, accounting, computer. It features greater flexibility of use; three sizes of winding reels are interchangeable, quick-threading, instantly removed or replaced and available with either large cores for re-transmitting (unwinding) or small cores for filing. Several other exclusive features.—*Cycle Equipment Co.*, 420 *Market St., San Francisco, Calif.*



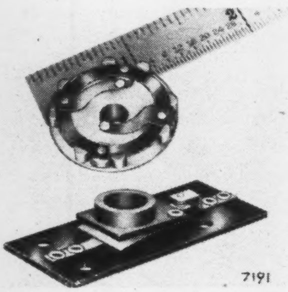
7128

For more information circle **268** on inquiry card.

TIME, SPEED, COUNT

CENTRIFUGAL SWITCH

New miniature "Syncro-Snap" for computers and business machines operates on same principles as larger "Syncro-Snap" centrifugal switches; features 0.25% accuracy and service life of 1,000,000 to 1,500,000 operations.—*Torq Engineered Products, Inc., Interstate St., Bedford, Ohio.*

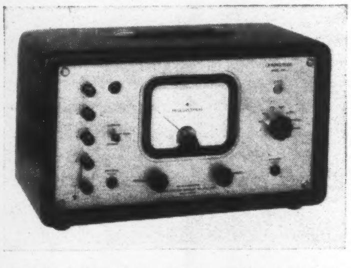


7191

For more information circle **269** on inquiry card.

MULTI-RANGE TIMERS

Two new models of "Chronotest" (made by Electronic Instruments, Ltd., in England): "Model 25E has eight ranges from 0-4 milliseconds to 0-10 seconds; "Model 25C" has six ranges from 0-40 microseconds to 0-10 milliseconds. As soon as timing operation is complete, time interval is instantly indicated and reading is maintained until circuits are intentionally



THE New CHAMPION

350

TYPE 350
SERIAL
CATHODE-RAY OSCILLOGRAPH
115 VOLTS
CPS
110 WATTS
INTENSITY
FOCUS
Y POSITION
X POSITION
SYNC AMPLITUDE
DU MONT
SWEEP RANGE
SYNC SELECTOR
Y CAL
X CAL
Y SELECTOR
X SELECTOR
Y D-C BAL
X D-C BAL
Y INPUT
EXT SYNC
SCALE
GATE
X INPUT

Not just another low-frequency cathode-ray oscillograph but a decidedly grown up instrument combining the best features of the laboratory standards by Du Mont which have gone before it. All these features and more:

- **Exceptional stability—all voltages regulated**
- **No drift—less than 10 mv in 8 hrs. including 10% line voltage changes**
- **Identical X- and Y-amplifiers**
- **Amplitude calibration on both axes**
- **Accurate X-Y plotting at frequencies from d.c. to 150 kc.**
- **Ideal for precise phase shift measurements—less than 1° relative phase shift below 150 kc.**
- **Superior sweep linearity with hard-tube circuit**
- **Automatic beam brightening on sweeps**
- **Automatic beam brightening for transient plots**
- **High brightness—3KV acceleration**
- **Provision for very slow sweep rates**

CONDENSED SPECIFICATIONS:

VERTICAL DEFLECTION: *sinusoidal response,* flat to d.c., down not more than 30% at 150 kc; *deflection factor,* 20 p-p mv/inch.

HORIZONTAL DEFLECTION: identical to vertical axis except *deflection factor,* 25 p-p mv/inch (due to higher deflection factor of horizontal deflection plates).

SWEEPS: *mode,* driven or recurrent; *frequency,* 2 cps to 30 kc; *beam gate,* automatic during forward sweep.

AMPLITUDE MEASUREMENT: (both X and Y axes) *range,* 0.1, 1, 10 and 100 volts full scale; *accuracy,* ±5%.

PHASE SHIFT: *amplitude controls at max.,* less than 1° below 150 kc.

PRICE ONLY **$395**

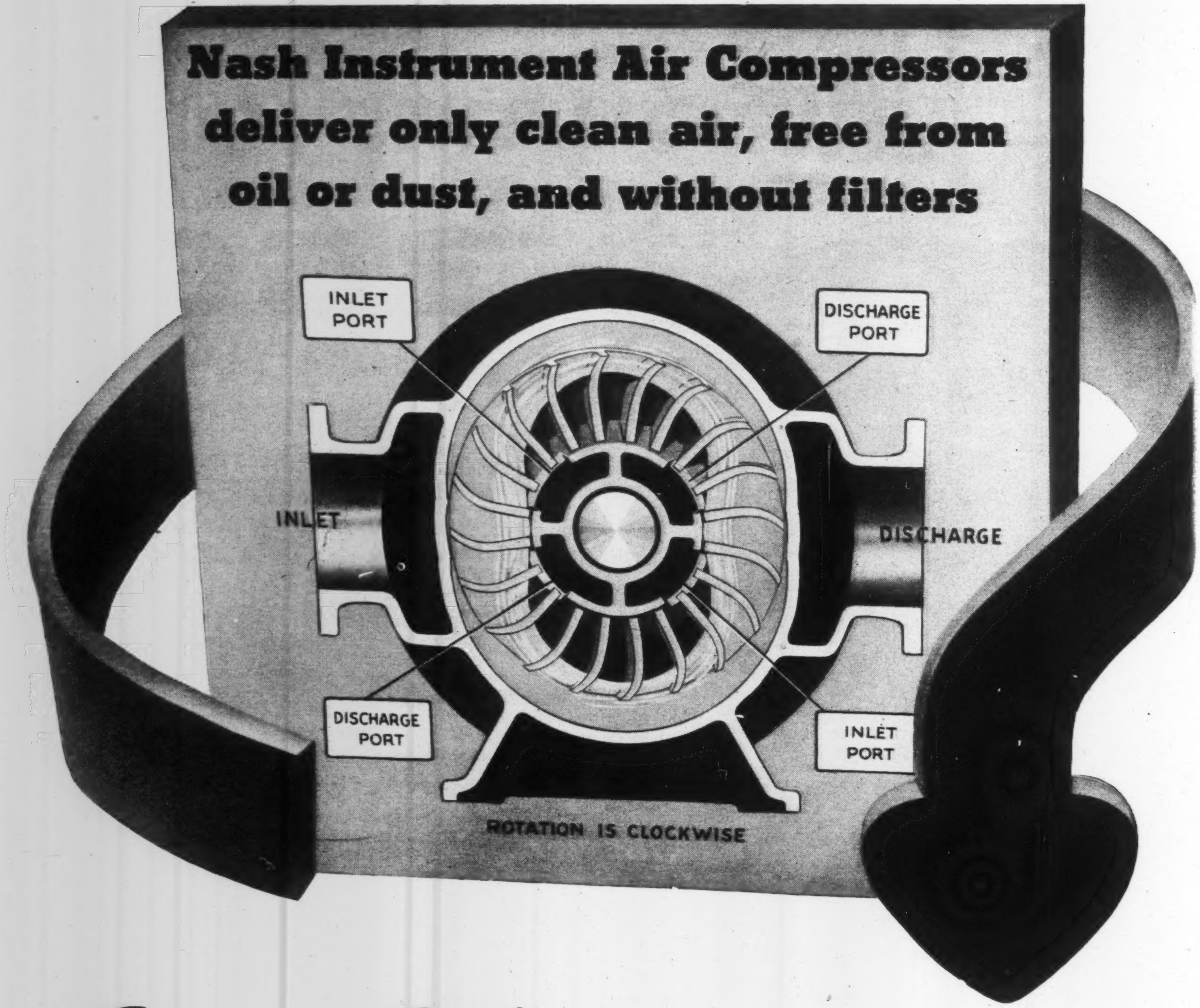
IMMEDIATE DELIVERY!

DU MONT

Write for complete specifications

ALLEN B. DU MONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J.

For more information circle **89** on inquiry card.



Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

cleared for next operation. Immediate shipments from New York stock.—*Herman H. Sticht Co., Inc., 27 Park Pl., New York 7, N. Y.*

For more information circle **270** on inquiry card.

SPEED INDICATOR

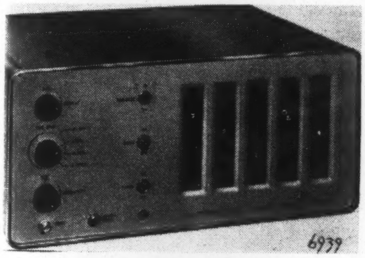
New "Jaquet Indicator No. 2304-I," specially designed for measuring slow linear speeds such as encoun-

ered in welding, plastic extrusion, tc., covers all speeds from 0 to 300 pm. With 3" circumference wheel, ach small dial division represents ¼ ipm.—*Herman H. Sticht Co., Inc., 27 Park Pl., New York 7, N. Y.*

or more information circle **271** on inquiry card.

FREQUENCY-PERIOD COUNTER

New "201A Frequency and Period Counter" is said to embody "many unique and exclusive features engi-



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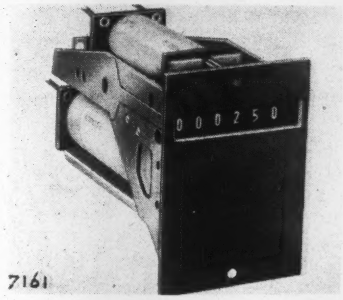
neered as standard equipment instead f extra-cost optional features." A rystal oven provides an accuracy of .0001%; also time bases of 0.1 sec., sec., 10 sec. and 1 cycle. Frequency ange 1 to 100,000 cps; period range) usec to 1 sec (automatic) and 1 c to no limit (visual); gate time 1 cle of unknown frequency (10 cy- es optional); long-term stability 5 arts per million per week.—*Com- uter-Measurements Corp., 5457 Cle- St., North Hollywood, Calif.*

r more information circle **272** on inquiry card.

6-DIGIT ELECTRIC COUNTER

New six-digit electrical impulse unter with instantaneous electrical set is 4½" long; features side angle ace construction for strength, is itable for flush mounting. Counting



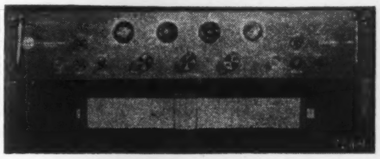
7161

speed up to 10 impulses/sec (special models up to 25 impulses/sec). Reset voltage can be different from the impulse voltage.—*Landis & Gyr, Inc., 60 E. 42nd St., New York 17, N. Y.*

For more information circle **273** on inquiry card.

FREQUENCY COUNTER

New "Model 130" events-per-unit-time instrument utilizes glow-tube decades and simplified circuitry to



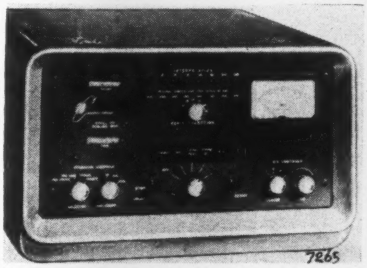
achieve "exceptional reliability, sensitivity, and versatility." Counting intervals 0.1 and 1.0 sec; display time variable from 0.1 to 5 sec. At minimum display, five readings per second are obtained. With display control in manual position, "Model 130" can be used as a high-speed electronic counter; counting is controlled by manual gate switch. Frequency response 10 cps to 100 kc.—*Hupp Instru/Mation Co., 2119 Sepulveda Blvd., Los Angeles 25, Calif.*

For more information circle **274** on inquiry card.

NUCLEONICS

MICROSECOND BINARY SCALER

New "Model 183," for use with Geiger-Muller or fast scintillation detectors, has a resolving time of 1



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usec, permitting its use with radiation detectors whose basic resolving time is 1 usec or less; instrument will provide a coincidence loss of less than 1% for an average counting rate of 600,000 cpm. A chassis switch changes

Continuous Process Refractometry

Increase your process efficiency with accurate quality control

Increased process efficiency and precise quality control are only two of the many advantages that result from the application of continuous process refractometry to chemical process streams. This unique physical principle is a quick and simple method of determining whether a specific material, or mixture of materials, meets required specifications.

Product variations can be detected with great rapidity because a sample from the process stream itself is continuously flowing through the instrument and is compared with a reference standard. The process can be adjusted to maintain product characteristics within the desired tolerance, with a minimum of sub-standard throughput. These savings alone can quickly pay for the cost of an instrument.

APPLICATIONS—The Barnes Differential Refractometer has wide applications in the chemical, food, refinery and other process industries. Many processes in these industries have used continuous process refractometry for years to monitor product quality. For example, refractometry may be used to control:

Hydrogenation—of fats and oils in food and chemical streams;
Polymerization—of hydrocarbons, vinyls, styrenes, etc.;
Distillation—of petroleum or other fractions;
Blending—of binary mixtures.

OPERATION—The Barnes Refractometer measures an *unchanging* and *basic physical characteristic of a material:* refractive index. This gives a *true* measurement of stream composition—not a measurement of an environmental variable such as temperature, pressure, flow rate, etc.

The Barnes Refractometer provides a continuous indication of the difference in refractive index between the reference liquid and the continuously flowing sample from the process stream. Differences may be indicated on a scale at the front of the instrument, or they may be transmitted as electrical signals to a recorder controller.

SPECIFICATIONS—The Barnes Refractometer has an accuracy of better than ±½% and is available in three models with limiting sensitivities of refractive index covering 0.0001, 0.00001, 0.000002. The optical system is sealed against contamination; the entire instrument is explosion-proofed; the servo measuring system is of the null balance type for highest accuracy.

The Barnes Application Engineering Group is ready to assist you in evaluating the use of refractometry to your control problems. Special Data Sheets to help better service your problems are yours for the asking.

Complete description of the Barnes Refractometer and Data Sheets will be mailed upon request. Barnes Engineering Company, Stamford, Conn.

BARNES ENGINEERING COMPANY
CONTROL THROUGH ANALYSIS

For more information circle **90** on inquiry card.

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During the past decade, employment at Burroughs has grown from 8,500 to 26,000 . . . new and better methods of processing figures and information so essential to the successful business life of America have been developed. Through continued sound research for ideas to meet the needs of commerce, industry and government, it can be expected that the future will hold even greater growth and accomplishments for Burroughs and those who share this anticipated growth with us.

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resolution time to 5 usec when used with Geiger counters whose recovery time is about 50 usec or more. Eight scaling stages (256) followed by a four-digit electrically-reset register. Predetermined count circuit can be used to automatically stop count after 10, 100 or 1000 register counts.—*Nuclear Instrument and Chemical Corp., 229 W. Erie Street, Chicago 10, Ill.*

or more information circle **275** on inquiry card.

MICA END-WINDOW COUNTER TUBE

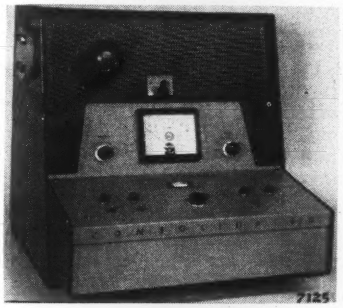
New "VG-22" tube has a thin mica end-window 2.3 to 2.8 mg/cm^2 thick, halogen quench, 200 volt plateau starting at 785 volts and operating at 900 volts; has a coaxial base and is mechanically and electrically interchangeable with "1B85" and bismuth screen type "6306" counter tube. —*Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

For more information circle **276** on inquiry card.

MECHANICAL TESTING

LEAK DETECTOR

New "Type 24-210" leak detector for production-line testing of either evacuated or pressurized systems combines low cost with high sensitivity. It is a simplified mass spectrometer which responds only to the presence of helium as a tracer gas. By probe or air-sampling methods, it will detect one part of helium in 300,000 parts of air. All operating controls and electronic components are accessible from the front. An audio alarm and a mobile workstand are among available accessories.—*Consolidated Electrodynamics Corp., Pasadena, Calif.*



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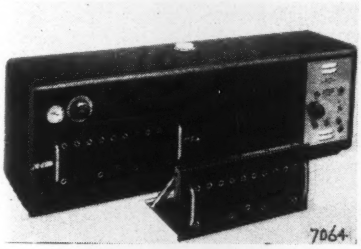
or more information circle **277** on inquiry card.

TEMPERATURE TEST CHAMBER

New "Model TC-2A," completely portable and self-contained, is a low cost unit for production line tests of mall products such as instruments, ubassemblies, components, etc. New nticipator-type thermostat provides xtremely accurate temperature control.—*Statham Development Corp., 2411 W. Olympic Blvd., Los Angeles 4, Calif.*



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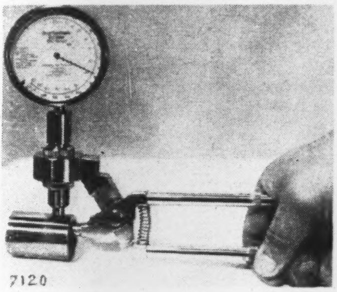
or more information circle **278** on inquiry card.

"POCKET" HARDNESS TESTER

New "Oppel" (West German made) hardness tester is said to be "the one simple, low-cost instrument that covers the five most widely used hardness scales."—*Company for Technical Progress, Cincinnati 29, Ohio.*



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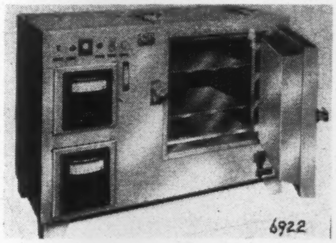
For more information circle **279** on inquiry card.

CIRCULATED-AIR OVENS

New "Con-Wate Ultra Temp Horizontal Airflow Mechanical Convection Ovens," with temperature range to 1200°F, automatically provide constant air-weight circulation at all temperatures, to give greater heating efficiency than do previous models.—*Blue M Electric Co., 138th & Chatham Sts., Blue Island, Ill.*



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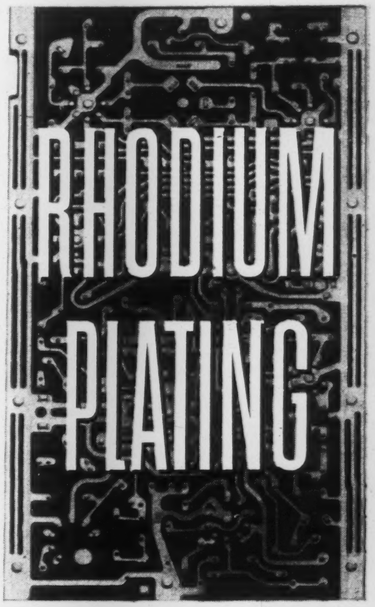
For more information circle **280** on inquiry card.

NON-DESTRUCTIVE TESTER FOR BONDED MATERIALS

New "Ultrasonic Bond Analyzer" will enable makers of airframes, missiles and helicopters to test strength of adhesive bond material without destruction of the unit under test, thus removing a major obstacle to full-

PROTECT
PRINTED
CIRCUITS
AGAINST
CORROSION...



Rhodium over nickel, or over silver in printed circuits—is only one of the many invaluable applications of Rhodium in electrical and electronic products. It improves performance wherever a low resistance, oxide-free contact is desired. Rhodium plate assures low noise level for moving contacts, low and stable contact resistance . . . and amazingly long wear.

For complete details send for free booklet on "Rhodium Plating" and its advantages.

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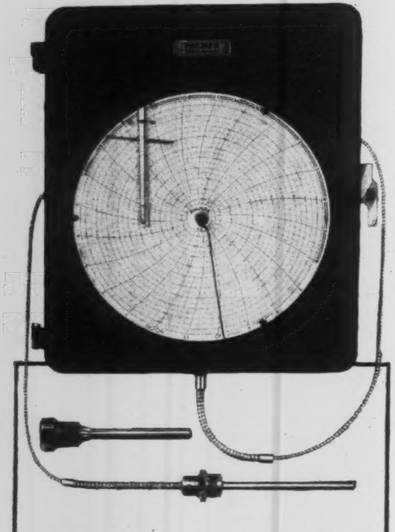
For more information circle **91** on inquiry card.

PALMER

MERCURY ACTUATED

recorders

Into this modern Mercury Actuated Recorder has gone all the skill of Palmer master craftsmen.



Readings are clearer, smoother and more precise than ever thought possible. In fact readings are so amazingly improved that maintenance is never needed under normal uses.

Recording Thermometers feature twelve inch die-cast aluminum case with black wrinkle or white satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 to 1000°F. or Equivalent in °C.

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Consult your Classified Directory

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory,
Recording and Dial Thermometers
Cincinnati 12, O.

For more information circle **92** on inquiry card.

scale use of honeycomb construction. Analyzer comprises a sweeping oscillator, a barium-titanate transducer, maker's "Type 304-AR" CRO and "Type 302" oscillograph-record camera. Equipment, developed by Stanford Research Institute under contract to Wright Field, weighs 125 lb, is about 20x20x22" in size.—*Allen B. Du Mont Labs., Clifton, N. J.*

For more information circle **281** on inquiry card.

WELDER DYNAMOMETER

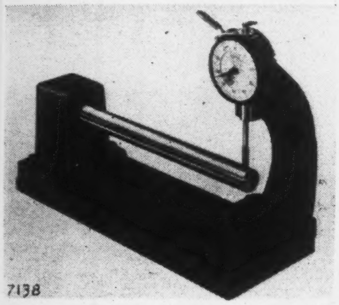
New "Force Gauge" makes possible dynamic measurements (on an oscillograph) of force changes between electrodes of resistance welding machines. It is of strain-gage type, mounted on a cantilever beam of non-magnetic materials. One end attaches to horn of lower arm; other end mounts on front of machine base plate. Thus, cantilever beam resembles hypotenuse of a right angle and can be adjusted to accommodate machines having throat depths from 12" to 60" by means of a three-section telescopic tube arrangement. Oscillograms can be made of both electrode force and secondary current simultaneously, without any undesirable modulation of electrode force trace due to magnetic pickup.—*Sciaky Bros., Inc.,* 4915 *W.* 67*th St., Chicago* 38, *Ill.*

For more information circle **282** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

THICKNESS GAGES

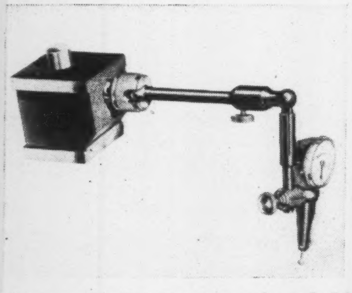
New "Models KB-410 and KB-411" deep-throat dial thickness gages are fully adjustable for measuring thickness of tubing, sheet material, etc. "KB-410" has an adjustable throat depth from 4" to 8"; "KB-411" from 8" to 12". Also, mandrel can be removed entirely so that gage can be used as a simple comparator.—*Federal Products Corp.,* 1144 *Eddy St., Providence* 1, *R. I.*



For more information circle **283** on inquiry card.

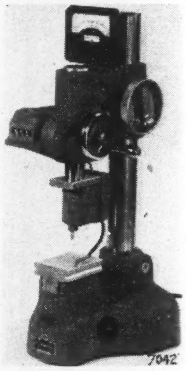
MAG-BASE INDICATOR HOLDER

New "No. 657 Magnetic Base Indicator Holder" simplifies set-up, checking and inspection jobs. Powerful permanent-magnet type base holds firmly in any position. Large-diameter push button turns magnetic force on or off, makes it possible to position and secure the base with one hand. —*The L. S. Starrett Co., Athol, Mass.*



For more information circle **284** on inquiry card.

DIRECT SETTING GAGE

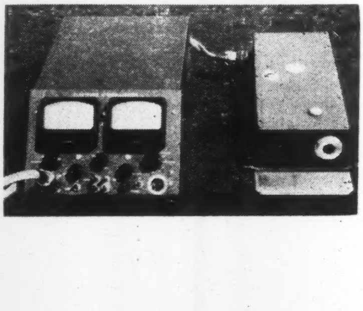


New "Direct Setting Electrolimit Gage" is said to be "ideal for gaging parts of similar but different sizes, for gaging several dimensions on a single part, for use as a comparator on short runs . . ." Features: (1) quick easy setting direct to 0.0001" without use of masters; (2) reads direct to 0.00005" on a full scale of plus and minus 0.001". Total range of gage 6". Standard gage blocks are used for even inches; fractional inch settings are obtained by precision micrometer screw.—*Pratt & Whitney Co., Inc., West Hartford* 1, *Conn.*

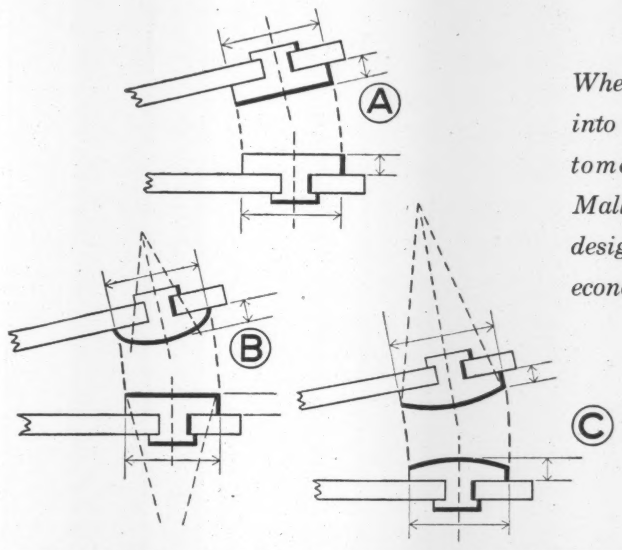
For more information circle **285** on inquiry card.

AUTOCOLLIMATOR

New "Electronic Autocollimator" optically measures minute changes in angles and presents information in the form of a direct voltage proportional to angle measured. Two units: (1) optical unit projects a parallel beam of light to a mirror (or other reflecting system) which can be 100 feet away. Beam is reflected back into optical unit and is picked up by photomultiplier tubes which transform light beam into electric energy to be



MALLORY



When Original Design A ran into alignment trouble, the customer proposed design B. Mallory engineers recommended design C as the most efficient and economical solution.

How economical are *your* contact designs?

Mallory Contact Engineering Offers Five Ways To Improve Economy

1. **The most effective contact material** from the extensive line developed by Mallory. More economical alloys often can satisfy *actual* service conditions.
2. **The most economical contact design** . . . for your purchasing, production and product needs.
3. **The most economical backing material** . . . from a group of Mallory alloys developed for this use.
4. **The most economical backing member design**. . . in relation to contact and product design requirements.
5. **The most economical method of assembly** of contact and backing member.

By coordinating *all* these important elements of contact design, Mallory can help you put into effect a long-range plan for cutting contact cost and assuring peak performance.

DESIGN of electrical contacts is an engineering job in which Mallory's specialized experience can often lead to substantial savings for you. A case in point—a manufacturer of circuit breakers wanted to use a combination of flat and radius-faced contacts to lick an alignment problem in production. This design required buying and stocking of two separate contact parts.

Mallory contact engineers came up with a money-saving improvement. They recommended a modified radius design to go on both the stationary and moving contacts. Substantial production time was saved by elimination of the alignment difficulty in assembly. In addition, by buying a *single* type of contact engineered for the job, instead of two separate designs, the manufacturer cut his inventory problem in half, simplified purchasing and handling, and saved a significant percentage of direct contact cost as well.

There's a good chance that you can realize comparable savings on your own contact applications, by bringing your problems to Mallory specialists. The complete engineering job that our staff can undertake will assure you of gaining the maximum in performance . . . at the peak of economy . . . for your specific requirements. For a consultation, write or call Mallory today.

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For more information circle **93** on inquiry card.

AWARD-WINNER
in telephone applications . . .

now available to you

STROMBERG-CARLSON TYPE "B" RELAY

If reliable operation of a large number of contacts has application to your work, you should examine this remarkable relay, manufactured with extreme precision.

Our gang-type "B" relay can be furnished with combinations of A, B or C contacts with a capacity of up to 60 form A contacts. It will accommodate six stacks of spring combinations which, due to special construction, occupy an unusually small space and make the relay desirable for group mounting.

This relay has been for years distributed exclusively and in large numbers to the Independent telephone industry. Expanded production facilities enable us now to offer it to the general engineering world. Like all our relays, it is designed to operate under extreme ranges of temperature and humidity.

On request . . . If you will write or call, and state the application you'd plan to use it in, we'll be happy to send additional information, and a catalog of our entire relay line. No obligation, of course.

S-C

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113 CARLSON ROAD, ROCHESTER 3, N. Y.

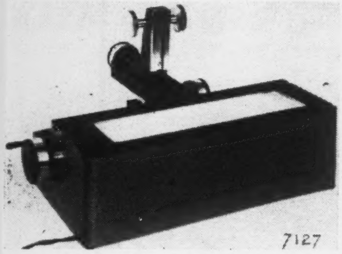
For more information circle **94** on inquiry card.

converted by (2) electronic unit into angular information indicated directly in seconds of arc. It simultaneously measures azimuth and elevation angular changes.—*Optronics, P. O. Box 3152 Inglewood 2, Calif.*

For more information circle **286** on inquiry card.

MICROSCOPE STAGE

Newly redesigned microscope stage can be purchased with or without toolmaker's microscope. Accuracy is 0.0005" in 12" range and 0.00025" in 3" range. Each lead screw has a large dial graduated to 0.001" with a vernier to read directly to 0.0001". Three precision ground screws afford a compound stage with ranges of 2½" x 3" or 12" x 3".—*Custom Scientific Instruments, Inc., Kearny, N. J.*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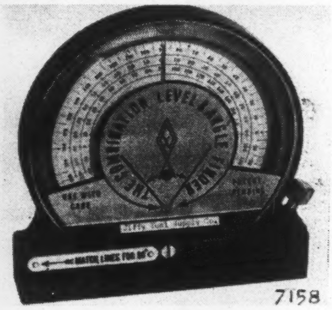
For more information circle **287** on inquiry card.

LEVEL AND ANGLE FINDER

New combination level and angle finder quickly gives exact measurements of angles of work in progress on machine tools. Carried in an aluminum case with Plexiglas face and tube, it is shock-proof and anti-magnetic.—*Jiffy Tool Supply Co., 109 E. 9 Mile Road, Ferndale 20, Mich.*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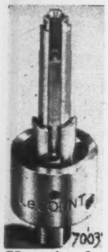
For more information circle **288** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

EXPANDING MANDRELS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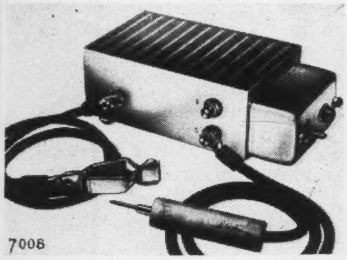
New "Micro-mite" line of miniature "Count-Centric" expanding mandrels is believed to be the first standard line of precision internal chuck type mandrels ever offered for bores between ¼" and ⅜". Only six sizes are required for this range.—*Le Count Tool Works, Inc., 390 Capitol Ave., Hartford, Conn.*

For more information circle **289** on inquiry card.

ETCHING MARKER

New "No. 140 Combination Etchtool and Demagnetizer" etches and marks stainless steel, steel alloys or carbides, and other ferrous metal materials with the ease and legibility of a pencil; is two units in one: it demagnetizes while it etches.—*The Luma Electric Equipment Co., P.O. Box 132, Toledo, Ohio.*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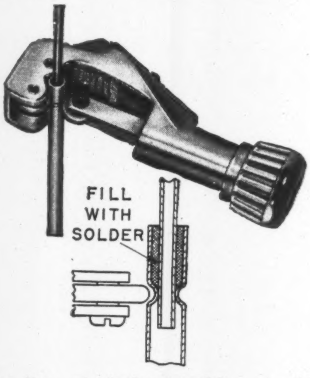
For more information circle **290** on inquiry card.

COMBINATION TUBE CUTTER AND CONSTRICTOR

New "No. 374-F" tool can be used for cutting tubing or for constricting a larger tube to outside diameter of a smaller one before making a solder connection. It is used with its standard cutting wheel for cutting tubing. A rounded-contour second wheel, carried in a special recess under reamer, is used in place of cutting wheel for constricting tubing.—*Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.*



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ABRASIVE MEDIUM

New "Speed-D-Burretts" is said to be a revolutionary, controlled-size, -shape and -grit abrasive medium for precision barrel finishing. Special compoundings of high-quality synthet-

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Please expedite my registration for six clinic classes.
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HERE is an opportunity for every company in the country to educate its production men in modern techniques for high-efficiency production.

HERE is an opportunity for every technical worker in the country to receive not only lectures but demonstrations on the most advanced production equipments in the world.

The Automation Show Management therefore offers

100 CLINIC SESSIONS

in conjunction with the THIRD INTERNATIONAL AUTOMATION EXPOSITION, November 26-30, 1956, New York, in the fields of

(1) Electronic Computers
(2) Process Automation
(3) Machine Tool Automation
(4) Office Automation
(5) Servomechanisms
(6) Electromechanical Components
(7) Electronic Components

Each clinic class will comprise a 90-minute *lecture and demonstration* based on *operating equipments* exhibited at the Exposition.

Each registrant can sign up for six clinic sessions in one (or more) of the seven basic fields.

For example, registrants of the Computer Clinic of the Second International Automation Exposition chose six of the following nine classes:

1. The Austin Co. (special-purpose computers)
2. Clevite-Brush (TapeDrum data handling)
3. Bendix Aviation (digital differential analyzers)
4. Berkeley-Beckman (analog computers)
5. Goodyear Aircraft Co. (analog computers)
6. Electronic Associates, Inc. (analog computers)
7. International Business Machines (digital data processors)
8. Librascope, Inc. (digital computers)
9. Teleregister Corp. (Magnetronic data systems)

This year, each computer clinic registrant can choose from the following:

Bendix Computer Div.; Berkeley Div., Beckman; Brush Electronics; Commercial Controls; Computer Controls Co.; EECO Products; Electronic Associates; Goodyear Aircraft; International Business Machines; Librascope, Inc.; Philco Corp.; Potter Instrument Co.; Reeves Instrument Co.; Remington Rand Div.; Teleregister Corp.; Underwood Corp.; Victor Adding Machine Co.; and Wang Laboratories.

Typical of the clinic sessions in other fields are the following:

Process Automation:

1. **Panellit** session on centralized process control and data logging, including programming and maintenance of system.

2. **P-K Industries** session on valves for high-pressure and high-pressure-drop application, with emphasis on P-K Paul Venturi design, including capacity, erosion, tight shut-off, and high-speed operation.

Servomechanisms:

1. Servomechanisms session of **Servomechanisms, Inc.,** featuring principles and practice of servosystem design and reduction to practice.

2. **PIC Design** session on Standardization of Electromechanical Components, emphasizing dimension factors and tolerances of electromechanical components—differentials, speed reducers, gears, etc. Also selection of A.G.M.A. Prec. Tolerances, and use of stock vs custom items.

The above clinic sessions are typical of 100 sessions, each of which will comprise lecture-demonstration classes in front of **operating equipments.** Depending on the size of room within which the equipment is located, classes will be restricted to from 10 to 35 registrants. Therefore, industrial managers and engineers are urged to make early reservation of seats for sessions on equipments in which they are particularly interested.

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For cleaning and polishing molds, dies & castings; removing film, coatings & enamel; blending in and polishing welded seams after rought grinding; polishing bearing surfaces and raceways; removing rust, heat-marks, tarnish, excess solder, fatigue lines, scratches, corrosion and other unacceptable surface defects.

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Investigate and test CRATEX Rubberized Abrasives—"the world's finest for industrial use"—unduplicated for lowering "unit costs." The "cushioned action performance" gives unparalleled results on production and assembly lines; in tool and machine shops. Send for Illustrated Catalog showing wide range of sizes, application details and prices.

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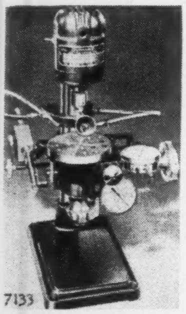
For more information circle **95** on inquiry card.

ic rubber and pure aluminum oxide go to make a medium that allows abrasive action "in the most remote corners and recesses of a part without fear of chipping . . . the only medium that will allow barrel finishing of complicated precision parts without fear of loading or damage." It is claimed that in precision industry that tries to hold to a 32-64 microinch surface, "Speed-D-Burretts" will improve on this required finish by 10-30 microinches. Many sizes and grits available.—*Speed-D-Burr Corp., 3613 San Fernando Rd., Glendale, Calif.*

For more information circle **292** on inquiry card.

MICRO-DRILL



New precision Micro-Drill has features that speed up difficult micro hole drilling down to 0.001" and enable unskilled labor to "learn to operate it in minutes." Collets used with unique magnetic chuck take most commercially-available micro-drills with shank sizes of 0.030", 0.040"and 0.061". (Thus obviates need for special drills.) Magnetic driver holds assemblies in drilling position. Runout is corrected instantly with a pencil or fingernail. Magnetic feature also speeds up drill changes as collet and drill assemblies are set up beforehand to perform a given series of drilling operations. Calibrated micrometer depth control permits positive stop within 0.0002".—*The Dumore Co., Racine, Wis.*

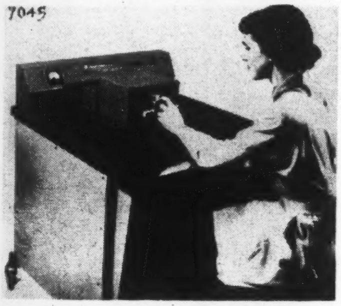
For more information circle **293** on inquiry card.

FILAMENT TRANSFORMER

New "T54207-A" designed particularly for use with maker's soldering instruments, is rated 6v, 12 w, 2 amp in continuous operation.—*Oryx Company, 9015 Wilshire Blvd., Beverly Hills, Calif.*

For more information circle **294** on inquiry card.

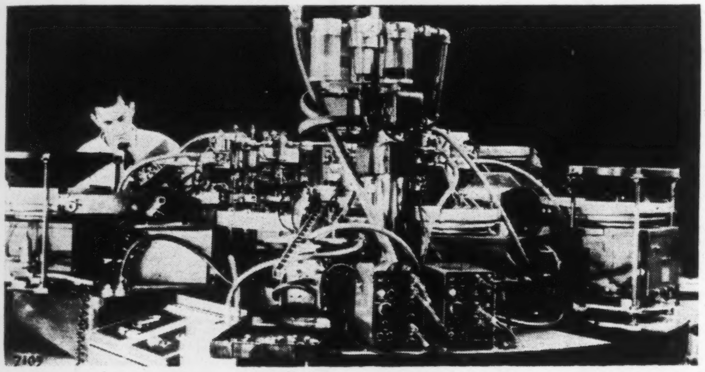
MAGNET CHARGER



New "Model 942" high-powered magnet charger is capable of charging large Alnico magnets, ceramic magnets, and other materials requiring large peak magnetizing forces: up to 200,000 ampere-turns peak magnetizing force. It comprises a 3000-v power supply with control and interlock circuitry and storage capacitors with Charger. Transformers, wire-wound fixture, adapters and inserts are available to charge rod, bar, ring, U, multi-pole rotor, and special permanent magnets.—*Radio Frequency* from 200 to 800 uf. Energy stored in capacitor bank is discharged by means of an ignitron in a single unidirectional pulse. Ampere-turn rating depends upon size and type of pulse transformer purchased to operate *Laboratories, Inc., Powerville Road, Boonton 14, N. J.*

For more information circle **295** on inquiry card.

AUTOMATIC ASSEMBLER

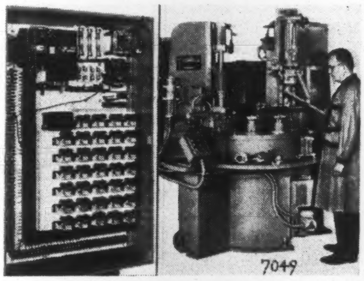


New "Multra" multi-purpose automatic assembly machine is shown turning out between 15,000 and 20,000 mercury batteries per 8-hour shift on a regular production basis. By changing tools, machine. It feeds, sorts, sizes, forms, orients and inspects five different parts. Should a part not be inserted at any station, sub-assembly with missing part is rejected at a later station but, meanwhile, no further parts are fed into it.—*Barnes Engineering Co., Stamford, Conn.*

For more information circle **296** on inquiry card.

AUTOMATIC PARTS ASSEMBLY

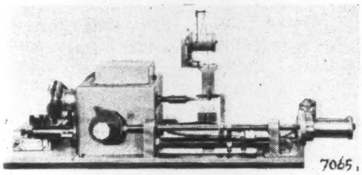
New eight-station assembly machine automatizes the feeding, positioning, assembling and removal of parts. Production rate 720 assemblies per hour. Control-panel with plug-in aircraft-type relays is about one-third the size of usual machine tool panel; includes provision to prevent assembly unless each component is correctly positioned.—*Omer E. Robbins Co., 24800 Plymouth Road, Detroit 39, Mich.*



For more information circle **297** on inquiry card.

COIL WINDER

New "Model 518-AM" variable-pitch space winder designed for long production runs features electric heel-and-toe pedal which starts machine and re-sets cam for each new winding, giving operator full use of both hands at all times. New automatic cam return actuated by a compressed air cylinder speeds up production and reduces operator fatigue. New time-saving instant automatic brake release frees spindle, permitting operator to unfasten start lead quickly. "518-AM" winds variable-pitch single-layer coils up to 3″ L by 3″ OD; wire sizes 18 to 46.—*Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.*



For more information circle **298** on inquiry card.

NAMEPLATE MATERIAL

New "Therma-Cal" is new type of anodized and etched aluminum foil nameplate, for use on crinkle, curved,

Chelsea
ADMIRAL
SYLVANIA
Winthrop
TRANSMITTER
RCA
EXECUTIVE

SUPERGAUGE
0
100
200
300
400
500
600
700
800
900
1000

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SUPERGAUGE®

...built
to last a lifetime!

With proper application, the new USG Supergauge will last a lifetime!

SEGMENT—stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . maintains accurate pitch diameter . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.

MONO-UNIT CONSTRUCTION—permits easy removal of complete gauge assembly for inspection and adjustment.

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LEGEND ON DIAL—gives complete description of socket, Bourdon tube and movement material for ready identification.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER—permits accurate repositioning of pointer.

These features are also available in USG Solfrunt Gauges with solid front construction.

Supergauges available in 4½″, 6″, and 8½″ sizes. For complete information on case styles, materials of construction and connections write for Publication 1819.

USG
UNITED STATES GAUGE
Division of American Machine and Metals, Inc.
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Home of the **SUPERGAUGE**

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Now you can solder as easy as you write! —with HEXACON INSTRUMENT SOLDERING IRONS —for fast soldering and long life on constant duty

Because of new efficient design, these tiny tips out-perform irons with larger tips and higher wattages. HEXACON offers a new standard in soldering iron efficiency for every conceivable need in the soldering of miniature assemblies.

Send for new circular No. 127 giving more details and comparative competitive performance data.

2 OZ. SUPER-PENCIL IRONS*
No. 25S 25w. 1/8" tip $6.00
No. 26S 30w. 3/16" tip $6.00

3 OZ. BANTAMWEIGHT HATCHET IRONS*
No. 25H 25w. 1/8" tip $6.50
No. 26H 30w. 3/16" tip $6.50

3 OZ. PIN-POINT IRONS*
No. P-25A 25w. 1/8" tip $6.00
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*Also available in higher wattages

INDUSTRY'S No. 1 HEXACON SOLDERING IRON

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Platinum Content provides unsurpassed resistance to corrosion . . long shelf life.

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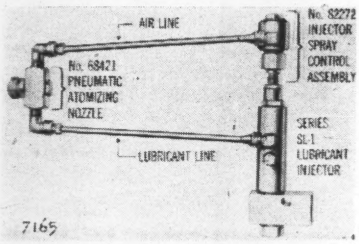
For more information circle 98 on inquiry card.

painted or uneven surfaces. Special sealing material produces a permanent bond without prior water soaking. To apply, user peels off paper liner which protects bonding adhesive, places nameplate on product, and applies heat for six seconds.—*North Shore Nameplate Inc., 214 Northern Blvd., Bayside, L. I.*

For more information circle **299** on inquiry card.

LUBRICATOR

New "MistOmatic Spray Control" automatically applies a controlled premeasured quantity of mist lubrication on open gears, cams, and similar open surfaces requiring fine distribution of oil. It is for use in conjunction with maker's centralized lubrication systems to permit automatic simultaneous lubrication of both closed bearings and open surfaces at preset time intervals.—*Lincoln Engineering Co., Industrial Division, 5703-31 Natural Bridge Ave., St. Louis 20, Mo.*


AIR LINE
No. 82272 INJECTOR SPRAY CONTROL ASSEMBLY
No. 68421 PNEUMATIC ATOMIZING NOZZLE
SERIES SL-1 LUBRICANT INJECTOR
LUBRICANT LINE
7165

For more information circle **300** on inquiry card.

COLD FABRICATING LAMINATE

New "Textolite (R) Cold Punch 11570" plastic laminate, with properties particularly suited for automatic production of electronic equipment utilizing printed circuits, is a high-insulation-resistance XXP phenolic, paper-base laminate which permits close registration punching at normal room temperatures. Its translucency permits visual check for accuracy of circuit registration. Other features include high flexural strength, low power factor, high heat resistance, and optimal uniformity.—*General Electric Laminated and Insulating Products Dep't, Coshocton, Ohio.*

For more information circle **301** on inquiry card.

METALLIZED PLASTICS

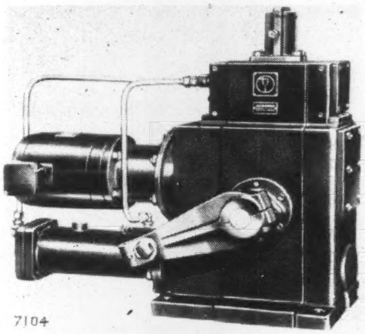
New metallized plastics are being produced by two licensees. Various products of continuous vacuum metallizing process can be used by many industries. Almost all flexible films are potential base substrates for bright metallic coatings. Metallized "Mylar" (duPont's polyester film) and cellulose aceate are available now; Metallized poly-ethylene and vinyl films will be offered soon.—*Foiltone Products, Inc., Cambridge 42, Mass.*

For more information circle **302** on inquiry card.

VALVES, etc.

SELF-CONTAINED CONTROLLER

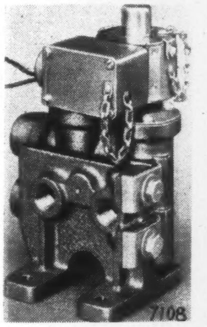
New "Powerpack Regulator" develops a powerful correcting action in response to a wide range of signals; is especially well suited for relief and reducing valve applications involving lever or butterfly valves. Force is greatly increased near closed position of valve: needed to shut valves tight or break sticking valves loose.—*Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.*


7104

For more information circle **303** on inquiry card.

FOUR-WAY VALVE

New "Crescent" 4-way solenoid valve for control of air, water and light oil to 150 psi conforms to JIC specs. Solenoid is inoperative when its cover is removed, and manual override is safe against accidental actuation. Valve can be converted to any practical current or voltage, ac or dc, by a simple coil change. Coil burnout has been eliminated by short-stroke pilot operation and generous power margin.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*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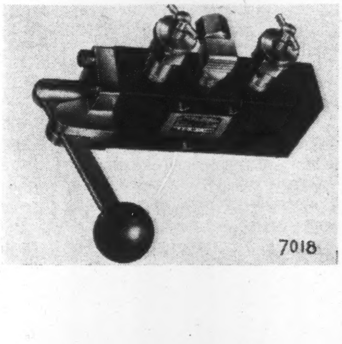
For more information circle **304** on inquiry card.

CYLINDER CONTROL VALVE

New "Model 500 Exhaust Speed Control Valve" is a throttling-type valve to mount directly in control valve exhaust ports; is made in ¼",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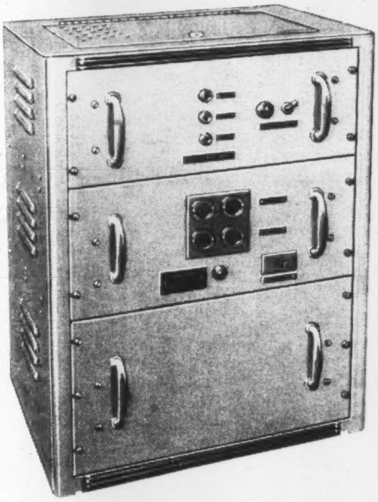
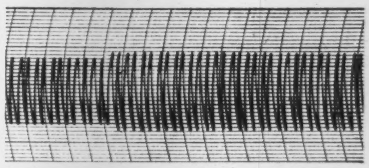
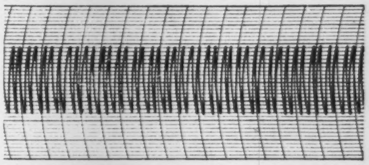
Regulation in *less than* ¹⁄₅₀th cycle...





Output of typical electromechanical regulator.



Output of Curtiss-Wright Distortion Eliminating Voltage Regulator from same input. Actual oscillograms of 60 cps voltage.

Actual 60 c.p.s. waveform

PLUS Pure Sine Wave Power

CURTISS-WRIGHT LINE REGULATOR

- **Electronically regulates r.m.s. and peak voltage simultaneously to ±1%.**
- **Reduces typical power line distortion to less than 0.3%.**
- **Furnishes 1.4 KVA of distortion-free power.**
- **Introduces no phase shift between input and output.**
- **Simultaneously provides additional 4 KVA of ±1% electromechanically regulated power.**

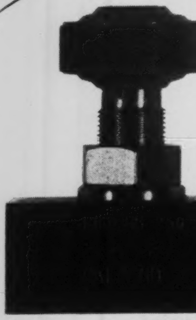
Faster recovery time (less than ¹⁄₅₀th cycle, or 330 microseconds) plus the unique ability to *eliminate* line distortion — these are the reasons why the Curtiss-Wright Distortion Eliminating Voltage Regulator has been chosen by more and more laboratories and production test departments. Besides general laboratory use, this line regulator provides simpler, more accurate calibration of meters . . . better design of transformers, synchros, motors . . . easier testing of such components, with fewer rejects . . . easier, more accurate measurement of magnetic properties and receiver sensitivity . . . better a.c. computer performance . . . elimination of fast line transient effects. Write for details.

Electronic Component & Instrument Sales Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION · CARLSTADT, N. J.

For more information circle **99** on inquiry card.

ROBBINS Leakproof Metering Valves



- Hi Vacuum to 6000 PSI.
- "O" Rings and Teflon or Nylon Seats are standard.
- Over-torquing cannot damage seat or needle as buffer plate and metering pin act as a forming die.
- Impossible to score needle or seat.
- Lifetime Valve—can be completely overhauled in a matter of minutes without disturbing plumbing or mounting.
- The cheapest valve in the long run.

Write for further details.

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Los Angeles 47, Calif.

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Protect your product.
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Use Leather Cases by . . .

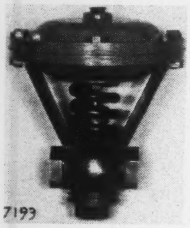
GRATON & KNIGHT Company
WORCESTER, MASSACHUSETTS

For more information circle **101** on inquiry card.

⅜" and ½" NPT sizes; screws into either or both exhaust ports of a 5-port 4-way valve to provide speed control of air-cylinder piston in one or both directions, or into exhaust port of a 3-way valve to regulate piston return speed on a single-acting cylinder.—*Modernair Corp., 400 Preda St., San Leandro, Calif.*

For more information circle **305** on inquiry card.

ON-OFF CONTROL VALVES

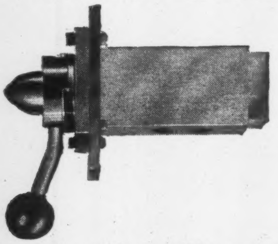


New "Series 700," for gas, oil, water, or steam, sizes ¼" to 1"; features quick-opening metallic or composition discs; working pressures 150 or 300 psi; standard, higher pressures on application. —*Uniflow Valve Corp., 19 Quine St., Cranford, N. J.*

For more information circle **306** on inquiry card.

FLOW REGULATOR

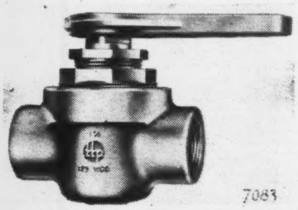
New model of maker's flow regulator, adapted for panel mounting, is for any system requiring adjustment of flow rate over a wide operating range. It has an aluminum body with internal parts of hardened steel and an adjustable control handle for either right or left rotation.—*Waterman Engineering Co., 725 Custer Avenue, Evanston, Illinois.*



For more information circle **307** on inquiry card.

MOLDED PVC PLUG VALVE

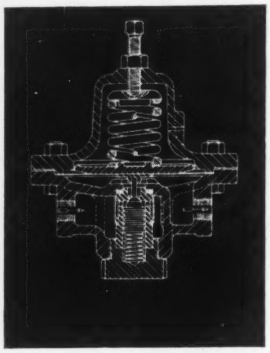
New plug valve is the first "self-lubricated" to be injection-molded of polyvinyl chloride. It will handle today's wide variety of corrosive fluids more efficiently and economically than conventional valves, minimize purging and eliminate many product contamination problems. Sizes now available: 1", 1½" and 2"; larger sizes soon.—*Tube Turns Plastics, Inc., 2929 Magazine St., Louisville 11, Ky.*



For more information circle **308** on inquiry card.

PRESSURE CONTROL VALVE

New and improved version of "Cash Standard Type D Pressure Reducing and Regulating Valve," fo liquids, steam and gases, feature 50% reduction in number of flang bolts (saves maintenance time) an introduction of a gasket seal at diaphragm flange for easier pressur range conversion. Iron, bronze, steel or SS body; bronze, SS, Nitralloy o Monel trim. Screwed ends from ¼" to 2".—*A. W. Cash Co., P. O. Bo 551, Decatur, Ill.*



For more information circle **309** on inquiry car

AVIATION

FLIGHT SIMULATOR

New "3-Axis Flight Simulator" reproduces equivalent flight conditions of modern high performance aircraft in pitch, roll, and yaw; can operate directly from output of a computer such as "REAC." It occupies a space of about 6 ft square.—*Color Television Inc., 953 E. San Carlos Ave., San Carlos, Calif.*

For more information circle **310** on inquiry card.

AIRBORNE TV CAMERA

New ruggedized television camera for airborne use (mfd by arrangement with Lockheed Aircraft Corp., Burbank, Calif.) produces excellent results at altitudes up to 70,000 ft, withstands more than 15 G without impairment of picture detail; performs perfectly when exposed to jet or rocket firing stand noises as high as 175 db.—*General Precision Lab., Inc., Pleasantville, N. Y.*

For more information circle **311** on inquiry card.

LANDING GEAR CONTROL

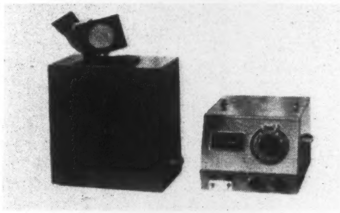
New "Model A1401" composite package contains all control elements required for pilot's management of landing-gear positioning; is a miniaturized version of maker's "A401-1"; conforms to standardized cockpit recommendations; fits a space 2⅞" wide by 3½" high and 2" deep.—*Avionic Products Engineering Corp., Cockpit Control Div., Dover, N. J.*

For more information circle **312** on inquiry card.

LABORATORY

FLUORIMETER

New "No. 365" fluorimeter can be operated in conjunction with any photometric unit or color-difference me-



ter, and serves as an additional exposure head for precise evaluation of fluorescent intensity of dyes, paints, textiles (treated or untreated), etc. Readings are reproducible to within a few parts per thousand. Indications correlate with visual estimates, and much greater precision is afforded.—*Gardner Laboratory, Bethesda, Md.*

For more information circle **313** on inquiry card.

X-RADIATION METER

New "Model 570 Condenser r-Meter" is first major revision in 25 years of instrument said to have been "the accepted standard of measurement of the X-ray beam since 1930." Over 20 different models of detachable-thimble ionization chambers are charged on r-meter, then removed and placed in radiation beam which causes discharge. Amount of discharge is a measure of radiation. Revised "Model 570" operates on 110 vac. Controls have been simplified with fast sure zeroing; design of scale has been improved for easier reading. Weight 5½ lb. Carrying case is provided for r-meter and several chambers.—*Victoreen Instrument Co.,* 5806 *Hough Ave., Cleveland* 3, *Ohio.*

For more information circle **314** on inquiry card.

DOUBLE CRYSTAL X-RAY DIFFRACTOMETER

New double crystal x-ray diffractometer (first commercially-available) was designed in collaboration with

utgers U's Materials Research Lab; olves problem of obtaining maximum esolution of beam emerging from the -ray tube by reflecting beam from a erfect crystal into long collimator. erfect crystal functions as an analyzer for any test crystal being in-estigated. Monochromatized beam's esolution is increased further by

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Conquest of the Sky

Heise gauges used by research engineers in the development of modern turbo-jet engines provide the reliability, correlation and repeatability necessary to scientific progress.

Actual operating conditions are reproduced in the Cox Test Stand built by Commercial Research Laboratories to test for optimum efficiency of jet fuel nozzles.

The six Heise gauges incorporated in the test stand feature in the vital and exacting performance which this instrument must accomplish.

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Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"
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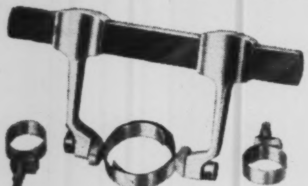
THE ROLYN

(Snake) Plier

An indispensable tool for assembly and dismantling of optical, radio, scientific instruments and all kinds of mechanical equipment.



The SNAKE PLIER consists of two coil springs with their turns interleaved, attached to two arms projecting from and sliding for adjustment of diameter on the main supporting bar. Two sets of springs are supplied and additional sizes are available.

Ideal for use in all fields where a positive friction grip is required in loosening, or tightening, of the most delicate and fragile threads, or thin wall tubing without danger of damaging, or of marking. Can be used on right or left hand threads. It is equally effective at any angle.

Exhaustive tests in Government workshops and research depts. have proved the efficiency of the Rolyn SNAKE PLIER.

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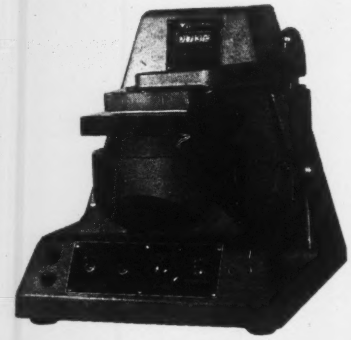
For more information circle **104** on inquiry card.

screening out troublesome alpha-2 component by means of precise slit systems at each end of collimator. Instrument's most original feature is combination of Geiger counter and photographic unit, to disclose test crystal's fine sub-structural details. —*New Brunswick Scientific Co., P.O. Box 606, New Brunswick, N. J.*

For more information circle **315** on inquiry card.

REFLECTANCE METER

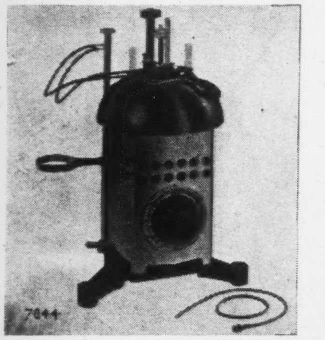
New "Model 50 Brightness Meter," for both paper buyer and manufacturer, employs reflectance plaques calibrated by National Bureau of Standards and therefore provides readings which are universally standard. Rapid method makes it of interest in plants where a large number of readings must be taken.—*Allegany Instrument Co.,* 1091 *Wills Mountain, Cumberland, Md.*



For more information circle **316** on inquiry card.

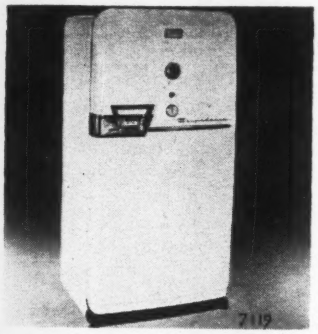
FLASH TESTERS

Redesigned Pensky-Martens Flash Testers are offered in both electrically-heated and gas-heated models; conform to specs of ASTM, AOCS, U. S. Govt and British Institute of Petroleum Technologists. Stepless heat control is a feature of both testers.—*Precision Scientific Co.,* 3737 *West Cortland St., Chicago* 47, *Ill.*



For more information circle **317** on inquiry card.

INCUBATORS

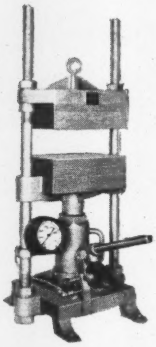


New refrigerated incubators feature convenient eye-level controls on outside of door for temperature control from 5°C to 50°C; dial thermometer and pilot light; hold 120 bottles of 190-ml size or 105 bottles of 300-ml size—*Central Scientific Co.,* 1700 *Irving Park Road, Chicago, Ill.*

For more information circle **318** on inquiry card.

SMALL LABORATORY PRESS

"Model 12-10" hydraulic press is especially suitable for vacuum molding of specimens of potassium bromide, or Perkin Elmer method; also for crushing, imbedding and other lab work. Platen area 7" x 10"; capacity 12 tons. —*Wabash Metal Products Co.,* 1562 *Morris St., Wabash, Ind.*



For more information circle **319** on inquiry card.

MONOCHROMATIC SOURCE

New "High Intensity Regulated Monochromatic Light Source" operates on 115-v 60-cps lines (50-cps models on special order). High-pressure mercury vapor lamp produces strong radiations at 365, 406, 436, 546, and 578 mu. Monochromatic filter turret allows insertion of four different filters or combinations.—*Phoenix Precision Instrument Co. Inc.,* 3803-05 *N. Fifth Street, Philadelphia* 40, *Penna.*

For more information circle **320** on inquiry card.

POWER SUPPLIES

LIGHT-WEIGHT POWER SUPPLY

New 100-amp "Type 28V100" utilizes long-life light-weight "Kotron" selenium rectifiers to effect size and weight reduction, greater reliability and improved electrical characteristics. Meets MIL-P-7212. Input 200-v 3-phase 400-cps; output 10 amp @ 28 vdc.—*Chatham Electronics Livingston, N. J.*

For more information circle **321** on inquiry card.

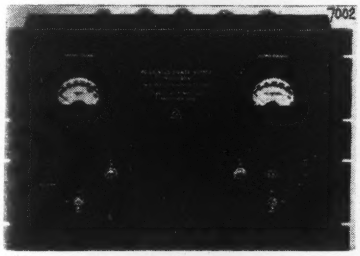
TEST SUPPLY

New "Model KM75 Aircraft Battery Substitute" operates from 115 vac 60-cps single-phase and provides 0 to 30 vdc continuously adjustable; ripple 0.5% at maximum rated load of 5 amp; meets MIL-E-7894 as a power source for testing and operating aircraft electrical equipment and components; mounts in standard 19" rack.—*Opad Electric Co.*, 69 *Murray St., New York* 7, *N. Y.*

For more information circle **322** on inquiry card.

HEAVY-DUTY SUPPLIES

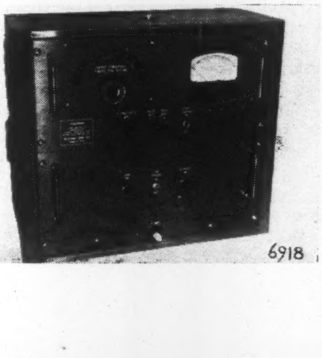
New "Models 60, 60M, 61 and 61M" in maker's "600 MA Series" are engineered primarily for industrial applications, and based on continuous-duty operation at maximum ratings. Features include precision regulation; vernier high-voltage adjustment; low output impedance and low ripple.—*Lambda Electronics Corp.*, 11-11 131 *St., College Point* 56, *N. Y.*



For more information circle **323** on inquiry card.

AC POWER SUPPLIES

New "Invertron," said to provide ac power outputs "of exceptional stability and accuracy" for critical tests, etc., is available in regular models that provide a wide range of output frequencies and power ratings,

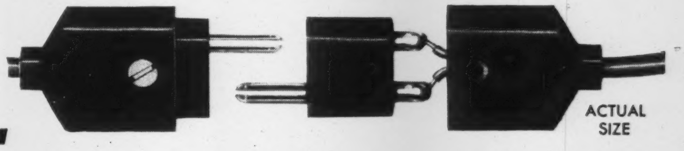


NEW Miniature Lightweight Thermocouple Connector

1-2-3 Ways NEW...

ALL-WAYS BETTER

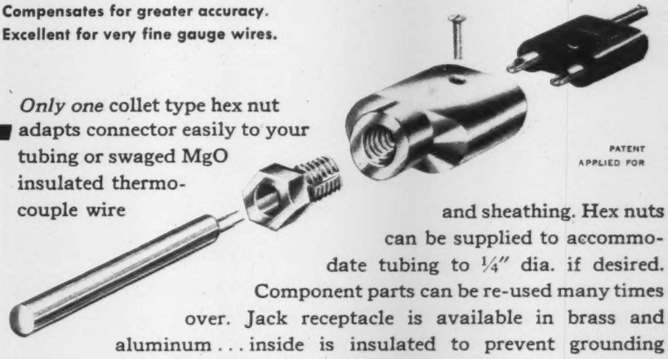
Unique, ultra-versatile design is adaptable to virtually all of your temperature measuring applications. Saves you time and money. Same ingenious jack design is used in all three models. Available in Iron Constantan, Copper-Constantan, and Chromel Alumel. Other Combinations of metals are available on special order.



1-

Connect or disconnect in a matter of seconds . . . only two screws in complete unit . . . small screwdriver, pencil soldering iron and solder are the only tools used to attach wires.

- Polarized . . . color coded . . . identified + and — . . . Eliminates errors in polarization.
- Positive lock can be supplied for use where vibration is a factor.
- Phenolic material withstands approximately 500°F.
- Compensates for greater accuracy.
- Excellent for very fine gauge wires.

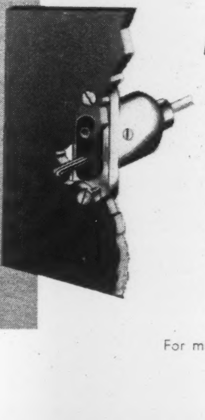


2-

Only one collet type hex nut adapts connector easily to your tubing or swaged MgO insulated thermocouple wire and sheathing. Hex nuts can be supplied to accommodate tubing to ¼" dia. if desired. Component parts can be re-used many times over. Jack receptacle is available in brass and aluminum . . . inside is insulated to prevent grounding effects. Terminal pins in connector are split and pre-set to produce clean wiping action each time contacts are engaged.

3-

Aluminum panel board adaptor has drilled and tapped holes in flanges to permit fast installation. Will accommodate leadwire up to 16 ga. with overall insulation dimension to 7/32" diameter. Prepunched connector panels can be supplied.



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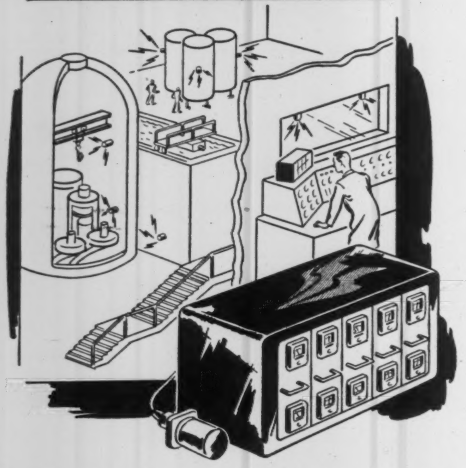
For more information circle **105** on inquiry card.

VICTOREEN
RADIATION MONITORING
AND
ALARM SYSTEMS

— CUSTOM DESIGNED TO YOUR SPECIFICATIONS —



Radiation Monitoring Systems maintain a continuous check on radiation intensity levels of radioactive gases, liquids or solids. These monitors, located at key positions throughout buildings will actuate alarms and interlocks, initiate the action of remote controls, recorders or other devices.

Radiation sensing units or detectors placed at one or more strategic measurement locations will communicate the radiation intensity at each location to a central control panel. The remote sensing units measure radiation intensity and through monitoring units and indicating meters located on the central control panel, alarms and interlocks are actuated the instant that the radiation level at any location reaches a pre-determined hazard point.

Victoreen Radiation Monitoring Systems are custom designed to meet the requirements of the specific installation. Central control station is of panel type construction and accommodates up to ten monitoring units. Modification to a Victoreen Monitoring System is easily accomplished by the addition or removal of a plug-in monitor unit at the central panel and corresponding detector at a remote location.

Either automatic or manual reset of station alarms are available. The alarm system may be triggered by either high level or low level radiation. Detectors are selected according to the type of radiation. Recorders can be provided to obtain permanent records of radiation levels at any or all sensing stations.

A check list which will assist in determining the specifications for a radiation monitoring system to fit your problem is available on request. Write for it today.

INSTRUMENTS DIVISION

The Victoreen Instrument Co.

3806 PERKINS AVENUE • CLEVELAND, OHIO

For more information circle **106** on inquiry card.

and custom models with frequencies ranging from subsonic to supersonic, fixed or variable, with accuracies from 0.5% to 0.001%; 0.5% regulation from no-load to full-load; power output ratings from milliwatts to kilowatts, single or multiphase. Shown: "Model 93-D-2," 90 va, 3-phase, output frequency continuously variable from 350 to 450 cps.—*Behlman Engineering Co., 114 So. Hollywood Way, Burbank, Calif.*

For more information circle **324** on inquiry card.

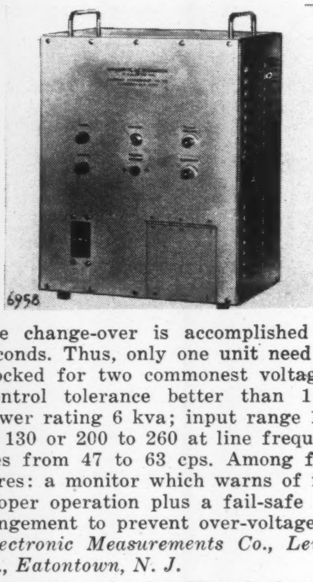
VOLTAGE REFERENCES

New tubeless miniature power-type "Voltage References" for use in production and lab test equipment and instrumentation where specifications demand highest stability (and where reference must furnish power to load) are designed to replace short-lived battery packs and bulky references such as chemical cells and VR tubes with their associated equipments; provide constant voltage through extremes of operating conditions including (a) line voltage variations 35-135 v, (b) load current changes, (c) overloads and short circuit conditions, (d) high ambient temperatures in confined spaces, (e) shock and vibration. Units measure $3\frac{1}{16}$ x $3\frac{9}{16}$ x $4\frac{7}{8}$"; weigh less than 4 lb; draw 25 va from a 400-cps source and are available in output voltages up to 20 vdc and in output currents up to 1000 ma.—*Timely Instruments & Controls Corp., 1645 W. 135th Street, Gardena, Calif.*

For more information circle **325** on inquiry card.

DUAL VOLTAGE REGULATOR

New "Model 260-A Automatic A.C. Regulator" operates for either 115- or 230-v line without derating. Voltage change-over is accomplished in seconds. Thus, only one unit need be stocked for two commonest voltages. Control tolerance better than 1%; power rating 6 kva; input range 100 to 130 or 200 to 260 at line frequencies from 47 to 63 cps. Among features: a monitor which warns of improper operation plus a fail-safe arrangement to prevent over-voltage.—*Electronic Measurements Co., Lewis St., Eatontown, N. J.*

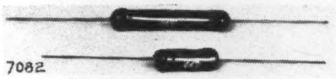


For more information circle **326** on inquiry card.

ELECTRICAL COMPONENTS

AXIAL LEAD RESISTORS

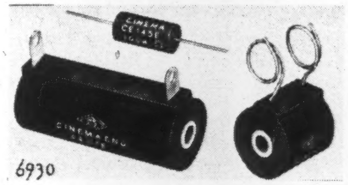
New vitreous axial-lead resistors, though somewhat smaller than standard ones, can dissipate as much power. Units have ceramic cores on which are pressed alloy caps with their integral leads. Core assembly is wound to proper resistance; junction is silver-brazed and coated with vitreous enamel which is fired to a glossy coating which is moisture-resistant and readily dissipates heat. Units can operate continuously at 300°C; are offered in 3, 5 and 10 watt ratings. —*Tru-Ohm Products, 2800 N. Milwaukee Ave., Chicago, Ill.*


7082

For more information circle **327** on inquiry card.

ENCAPSULATED RESISTORS

New "100 and 200 Series" resistors, available for immediate delivery, embody new features and improvements over earlier models: 15% greater wattage dissipation through vastly improved surface emittance; reduction of hot spots through greater thermal conductivity; much greater mechanical strength when operating at high ambient temperatures; no increase in cost.—*Cinema Engineering Div., Aerovox Corp., Burbank, Calif.*



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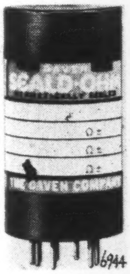
For more information circle **328** on inquiry card.

PLUG-IN RESISTOR NETWORK



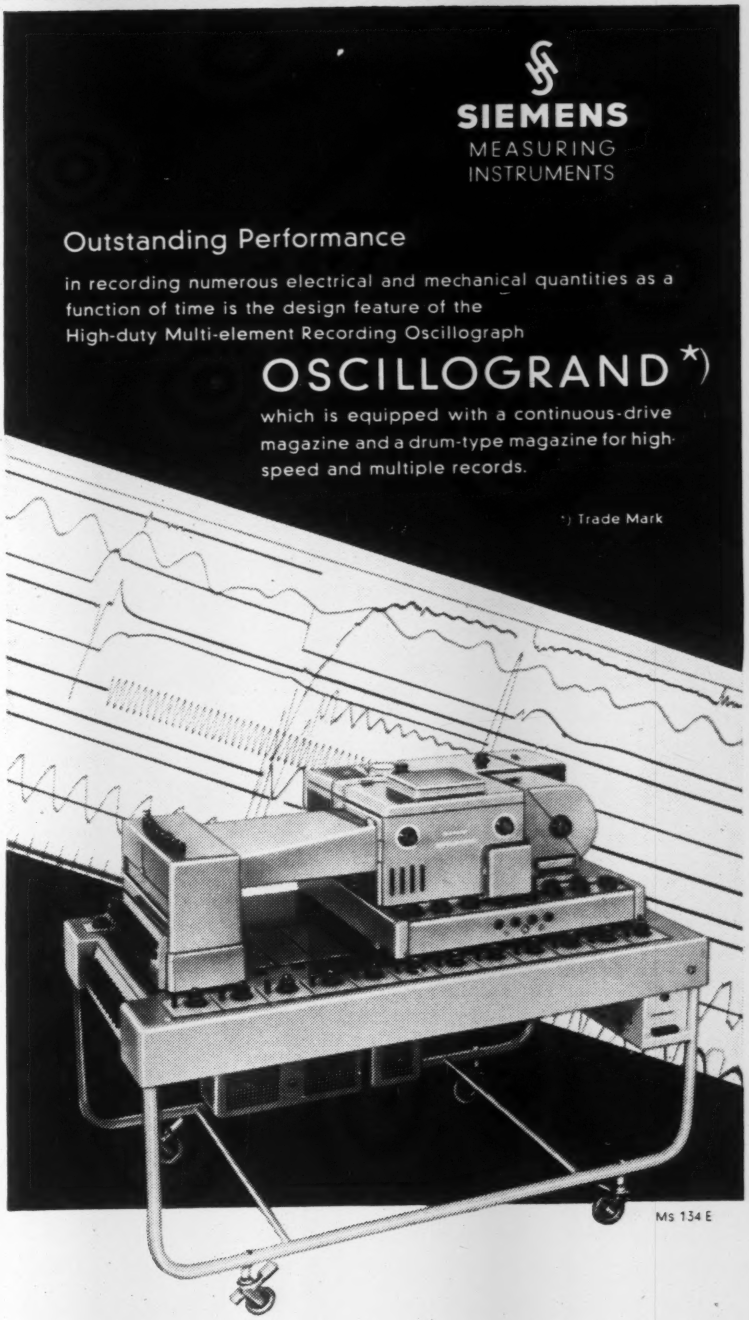
6944

New "Type 1299," is epoxy-molded and hermetically sealed; measures ⅞" D by 1¾" L. Base fits a standard 9-pin miniature socket. Unit can accommodate up to 8 individual resistors with a total resistance of 6 megohms. Individual resistor tolerances can be held to 0.05%. Each resistor can dissipate 0.5 watt. —*The Daven Co., 530 W. Mt. Pleasant Ave., Livingston, N. J.*

For more information circle **329** on inquiry card.

SNAP-IN VARIABLE RESISTOR

New "Type LR-70" self-supporting snap-in variable resistor takes minimal space in printed wiring; is supported by four legs: three regular voltage taps, and a larger case-ground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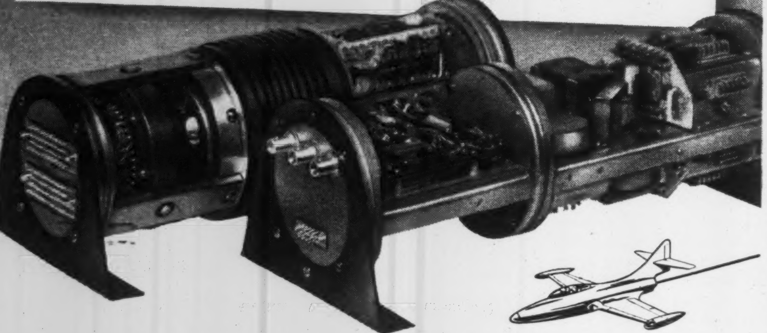
NEW FROM ASCOP
Low Level PW Multicoders
Open a Whole New Field
of Mobile Instrumentation!



Announcing a NEW Line of
SUPERSENSITIVE PW AIRBORNE EQUIPMENT
For Remote Measurement, Recording, Transmission

The new ASCOP D Series PW Multicoders provide, for the first time, supersensitive, low-level remote measurement of data from airborne vehicles. The extemely high input sensitivity, fast sampling rate, and wide selection of data channels (up to 88) of these new Multicoders . . . together with their critical accuracy, ultra-high altitude pressurization, and rugged design . . . suit them ideally to today's most important testing and prototype applications involving recovery and repeat use.

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FEATURES
- Operation from Standard Transducers and Pickups.
- Operation from Low-level Transducers.
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SPECIFICATIONS
- Input Sensitivity: 0-15 mv
- Input Circuit: Differential balanced to ground
- Data Channels: 43 or 88
- Sampling Rate: 20 or 10 samples per second per channel
- Output: Standard pulse width
- Power Requirements: 115V, 400 cycles

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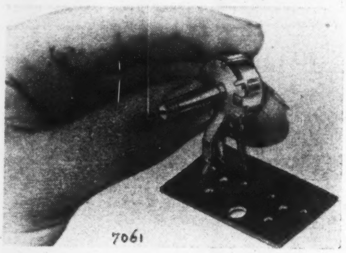


7061

leg. No mounting hardware required. Shaft can be left round or equipped with flat, screwdriver slot, split knurl, diamond or straight knurl, or tongue. Single or double-pole snap switches are available with ratings from 15 amp 15 vdc to 6 amp 125 vac. —*Stackpole Carbon Co., Electric Component Div., St. Marys, Pa.*

For more information circle **330** on inquiry card.

TRIMMER VDR

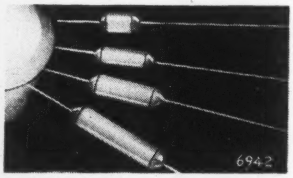
7073

New "RWT Subminiature Wire-Wound Trimmer Potentiometer," latest in maker's line of trimmer voltage-dividing resistors, provides 5% independent linearity and 10% standard accuracy of total resistance. Temperature coefficient of resistance wire is 0.0017% per C degree and trimmer's standard temperature range is −55°C to 95°C. Power rating 0.5 watt at 30°C. Dual-wiper sliding contact provides low-noise operation even when unit is subjected to vibration.—*Technology Instrument Corp.*, 531 *Main St., Acton, Mass.*

For more information circle **331** on inquiry card.

TANTALUM CAPACITORS

New "Type NT" subminiature tantalum polarized electrolytic capacitors are available in ratings from 0.5 to 16 vdc working; capacitances from 0.08 to 30 mfd depending on voltage; case sizes 3/32" or ⅛" dia and 5/32" to ½" long; operating temperature range −20°C to 55°C.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*



6942

For more information circle **332** on inquiry card.

CUP CORE COILS

New "Series 700" standard adjustable cup core coils cover range of 1.5 millihenry to 1 henry; are said to be ideal for telemetering circuits, etc. Features include phenolic housing which completely protects coil assembly; magnetic and electrostatic shielding; built-in tension for smooth "stay-put" tuning.—*North Hills Electric Co., Inc., 203-18 - 35th Ave., Bayside 61, L.I., N.Y.*

For more information circle **333** on inquiry card.

ELECTRONIC COMPONENTS

CONTROL THYRATRONS

New "Types GL-6807, GL-6808 and GL-6809" offer equipment designers three different base connections; will give improved performance over—yet be less expensive than—"GL-5545" which now is superseded. They are three versions of a 6.4-amp negative-control characteristic thyratron incorporating element and envelope construction designed to provide maximum cooling to eliminate major causes of inoperation.—*Tube Dep't, General Electric, Schenectady 5, N. Y.*

or more information circle **334** on inquiry **card.**

TWIN POWER TRIODE

New "Type 5998" for voltage regulation service offers higher amplification factor than "6AS7G" or "6080," features low microphonics, improved triode balance, reduction of plate current drift and absence of grid current. —*Chatham Electronics Div., Gera Corp., Livingston, N. J.*

or more information circle **335** on inquiry card.

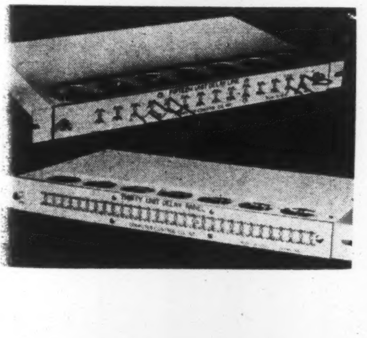
CRYSTAL FILTERS FOR FM

New crystal filters have extremely high selectivity at frequencies which obviate need for multiple conversions in VHF-UHF FM receivers. Their low insertion loss, linear transfer characteristics, and non-microphonic quality permit their location at any point of low signal level such as between mixer and i-f amplifier.—*Hycon Eastern, Inc., 1360 Soldiers Field Road, Boston 35, Mass.*

or more information circle **336** on inquiry card.

HIGH-FIDELITY DELAY LINES

New "Models 15 UD-1 and 30 UD-1 Unit Delays" package fifteen and thirty separate one-microsecond electrical delay lines. All delay lines are completely independent and can be used separately or joined in series to



New!

Miniature *Precision* Rotary Selector Switch

Here's the exceptionally positive action only a multi-leaf wiper, button-contact switch can offer—now in the smallest sizes consistent with the quality and dependability required for today's compact, precision equipment:

- Features solid silver alloy button-type contacts, collector rings, and spring suspension leaf-type wiper arms for low contact resistance—0.002 ohms.
- Integral lugs and contacts staked in glass-fibre Silicone-laminate stators. Lugs cannot turn or loosen. Stator material will not carbonize even if severely overheated. Terminations can be made mechanically secure *before* soldering.
- Molded Melamine rotor covering entire contact circle provides high voltage breakdown between decks.
- Outstanding moisture, humidity, and salt-spray resistance through use of passivated stainless steel, nickel-plated brass, Steatite, Nylon, molded Melamine, and Silicone-base glass-fibre laminate parts.
- Adjustable stainless steel stops—easily positioned.
- Uniformly high quality—cost-reducing mechanized productior and assembly.
- Small size—only 1¾" square. 1" deep for first deck, only ⅝" deep for additional decks.

CONDENSED SPECIFICATIONS

Shallcross "Miniature Series"

POLES PER DECK—1 to 4.
INDEXING (detent)—11¼°, 15°, 22½°, 30°.
MOUNTING—Single or 2-hole, with non-turn tang.
OPERATING VOLTAGE—to 1500 volts.
BREAKDOWN VOLTAGE—to 4000 volts.
BREAKING CURRENT—5 amp @ 125 V. ac.
CARRYING CURRENT—15 amp.

Shallcross

SHALLCROSS MANUFACTURING COMPANY, 510 Pusey Avenue, Collingdale, Pa.

For more information circle **109** on inquiry card.

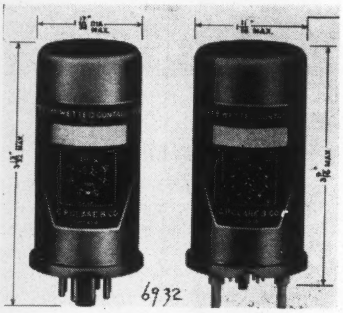
form a desired total delay by means of simple plugboard jumper connections. Basic 1-usec delay interval, accurate to within 2%, can be used directly with maker's line of "3C-PAC" and "3C-BLOC" computing packages. *—Computer Control Co., Wellesley, Mass.*

For more information circle **337** on inquiry card.

ELECTROMECHANICAL COMPONENTS

MERCURY-TYPE-RELAYS

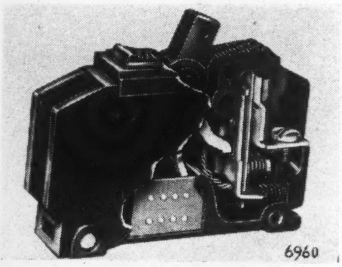
New multi-element mercury-wetted contact relays capable of reliably switching contact loads from microwatts to a quarter of a kilowatt for over a billion operations are available now in 2-, 3-, and 4-pole double-throw contact configuration. Each magnetic switch is sealed in a hydrogen-pressurized glass envelope. Absolutely maintenance-free.—*C. P. Clare & Co.,* 3101 *Pratt Blvd., Chicago* 45, *Ill.*



For more information circle **338** on inquiry card.

CIRCUIT BREAKER

New ambient-compensated "Quick-lag" circuit breaker for 120-vac lighting and power distribution panels acts with increased speed to protect circuit wiring, also eliminates tripping due to ambients between 30°F and 140°F, because of "ten-times rating" magnetic trip for short-circuit protection. Available in a full range of ratings from 15 to 50 amp.—*Federal Pacific Electric Co.,* 50 *Paris St., Newark* 1, *N. J.*



For more information circle **339** on inquiry card.

"CHROLUMINIUM MIRROR COATINGS
beautifully clear . . . give excellent definition"

says

J. W. Hetrick, President, The Skyscope Co., Inc., N. Y.

"Evaporated Metal Films has frequently gone out of its way to give us quick and additional service. Their Chroluminum° coatings are beautifully clear and give excellent definition where the slightest flaw would be highly magnified. We have some experimental pieces over ten years old that have been tossed about the shop with little or no care that are still usable. If treated with the care they deserve, they retain their lustre and brilliance for many years."

Mirrors coated by Evaporated have been an important part of every "Skyscope" telescope built, for over a decade.

°Send for free booklet describing Chroluminum and other Evaporated coatings.

EVAPORATED METAL FILMS CORP.
Ithaca, New York

For more information circle **110** on inquiry card.

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FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY

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ANY LIQUID

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HYDROSTATIC GAUGES
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For more information circle **112** on inquiry card.

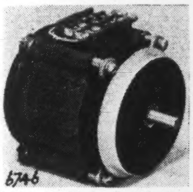
TIME DELAY RELAYS

New "Red Dot Series" thermal time delay relays have operating mechanism encased in a dust-tight shell. Durability is improved by elimination of all glass. Units fit octal tube sockets. Contact rating 3 amp at 230 vac; normally-open or n-c. Standard heater voltages are 6.3, 26.5, 115, and 230. Immediate delivery on ten standard delay times from 2 to 180 seconds; specials to order.—*G-V Controls Inc., Hollywood Plaza, East Orange, N. J.*

For more information circle **340** on inquiry card.

MOTORS, etc.

60-CPS TAC GENERATOR



New miniature 115-vac tachometer generator for industrial applications withstands environmental requirements of Armed Services; can be integrally coupled to maker's Instrument Servomotors having outputs of 1, 5, or 10 watts. With integral mount, backlash is zero. Output, with 100,000 ohm resistive load, is 6 v per 1000 rpm.—*Diehl Mfg. Co., Finderne Plant, Somerville, N. J.*

For more information circle **341** on inquiry card.

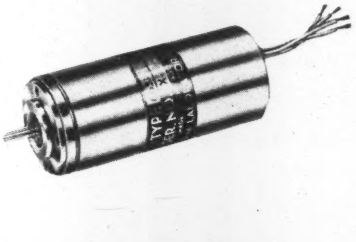
SYNCHRONOUS MOTORS

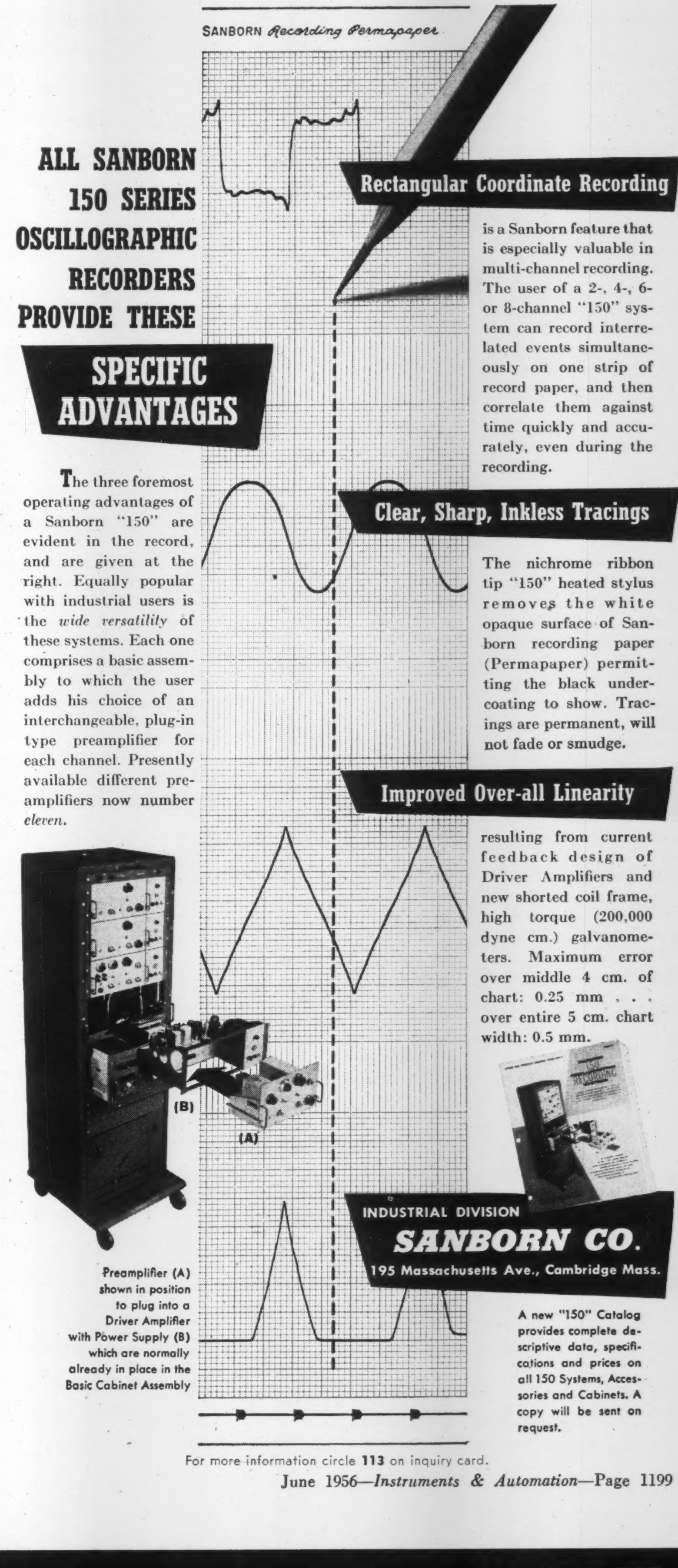
New complete line of miniature hysteresis synchronous motors is available. Units have been developed for instrumentation where specific requirements go beyond the capabilities of conventional synchronous motors (example: gyroscopes); are small, light and efficient; can be supplied for 8,000, 12,000 or 24,000 rpm speeds. With suitable phasing capacitators in circuit, they are adaptable for single-, two- or three-phase supply. Other features: exceptionally low vibration and noise level; smooth full torque for starting and accelerating. —*J. B. Rea, 1723 Cloverfield Blvd., Santa Monica, Calif.*

For more information circle **342** on inquiry card.

GEARED SERVOMOTORS

New Size 11 geared motors combine Size 11 precision servomotors and precision gear trains of same diameter (1.062"); lengths up to





ALL SANBORN 150 SERIES OSCILLOGRAPHIC RECORDERS PROVIDE THESE SPECIFIC ADVANTAGES

The three foremost operating advantages of a Sanborn "150" are evident in the record, and are given at the right. Equally popular with industrial users is the *wide versatility* of these systems. Each one comprises a basic assembly to which the user adds his choice of an interchangeable, plug-in type preamplifier for each channel. Presently available different preamplifiers now number *eleven*.

Preamplifier (A) shown in position to plug into a Driver Amplifier with Power Supply (B) which are normally already in place in the Basic Cabinet Assembly

Rectangular Coordinate Recording

is a Sanborn feature that is especially valuable in multi-channel recording. The user of a 2-, 4-, 6- or 8-channel "150" system can record interrelated events simultaneously on one strip of record paper, and then correlate them against time quickly and accurately, even during the recording.

Clear, Sharp, Inkless Tracings

The nichrome ribbon tip "150" heated stylus removes the white opaque surface of Sanborn recording paper (Permapaper) permitting the black undercoating to show. Tracings are permanent, will not fade or smudge.

Improved Over-all Linearity

resulting from current feedback design of Driver Amplifiers and new shorted coil frame, high torque (200,000 dyne cm.) galvanometers. Maximum error over middle 4 cm. of chart: 0.25 mm . . . over entire 5 cm. chart width: 0.5 mm.

INDUSTRIAL DIVISION
SANBORN CO.
195 Massachusetts Ave., Cambridge Mass.

A new "150" Catalog provides complete descriptive data, specifications and prices on all 150 Systems, Accessories and Cabinets. A copy will be sent on request.

For more information circle **113** on inquiry card.

Set up your AUTOMATIC TANK SWITCHING SYSTEM...

with "Varec"

PNEUMATIC LEVEL CONTROLS

Now you can operate your tank batteries in remote locations for long periods of time automatically. "VAREC" has developed a Pneumatic Level Control Valve used in conjunction with "Varec" float-operated automatic tank gauges, that provides control for automatic tank switching systems, pumps, motor operated valves, and other operating equipment.

Valve mechanism has snap action, and functions within a 30-foot range of tank height. Easily adjusted by Vernier screw.

Operates on separator gas, eliminating dependence on outside power source. Will work on compressed air where desired.

Cuts labor costs, increases recoveries, prevents over-flow losses, stabilizes "on-stream" production!

Write for full information regarding this modern tool for automatic tank control. Ask for "Varec" Bulletin CP-3030.

861-14

THE VAPOR RECOVERY SYSTEMS COMPANY

"Varec"

Compton, California, U. S. A.

Cable Address: Varec Compton Calif., (U.S.A.), All Codes

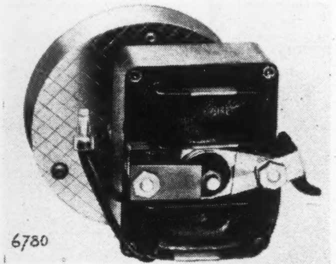
For more information circle **114** on inquiry card.

2.219". Motor is designed for 400-cps operation at either 115 or 26 v (other voltages if desired); normal stall torque 0.63 oz-in; no-load speed 6200 rpm.—*G-M Laboratories Inc., 4300 N. Knox Ave., Chicago 41, Ill.*

For more information circle **343** on inquiry card.

FHP MOTOR

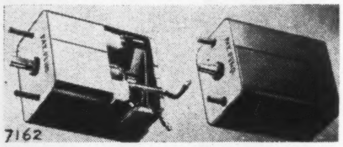
New induction type brake-motor guarantees less than 10° rotation before dead stop; is available with gear reductions from 4.5/1 to 2,592,000/1. Speed of synchronous motors is 1800 rpm. Either synchronous or nonsynchronous motors can be stalled for an indefinite period without damage to wiring or overheating; motors will operate on on-and-off loads for many years. Available in torques up to 240 oz-in.—*Gleason-Avery, Inc., Auburn 2, N. Y.*



For more information circle **344** on inquiry card.

RECTANGULAR MOTORS

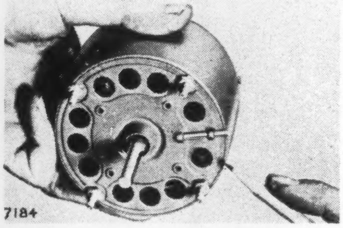
New motors, said to be the first rectangularly shaped, are designed to give the same output as comparable conventional round motors but in significantly less space and with maximal flexibility of installation; are available in 6, 12, 24 and 32-volt ranges with outputs up to 140 oz-in. —*Leece-Neville Co., 1374 E. 51st St., Cleveland 3, Ohio.*



For more information circle **345** on inquiry card.

FHP MOTOR

New "Type AL-4" incorporates into a small-diameter motor the design and construction features of "Type AY." It is 4-pole, 1550 rpm, 115 or 230 v, 60 cps; also available in odd voltages



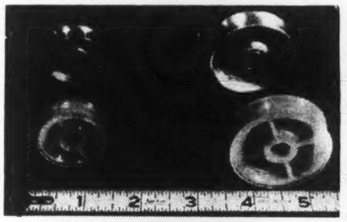
and frequencies or in either open-ventilated or totally-enclosed construction. It develops 1/250 to 1/15 hp.—*Redmond Company, Inc., Owosso, Mich.*

For more information circle **346** on inquiry card.

MECHANICAL COMPONENTS

NYLON PULLEYS

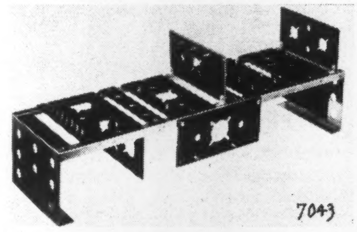
New Nylon pulleys have advantages over metal machined pulleys. One customer found total cost less than buying his metal type pulleys and, on subsequent reorders, cost will be appreciably less. A further advantage: Nylon is a self-lubricating material; can eliminate oilite bearing. Over-all weight of set of pulleys in one application has been decreased by about 5¾ lb.—*Dayton Rogers Mfg. Co., Minneapolis 7, Minn.*



For more information circle **347** on inquiry card.

CHASSIS KIT

New "3-D Chassis Kit" combines unrestricted versatility in assembly variations with time-saving simplicity; comprises end brackets, side channels, terminal strips, miniature and octal tube socket plates, component mounting boards, mounting brackets, double-end press-in terminals, self-tapping screws, pot mounting boards, and rack mounting plates. Plastic used in all mounting boards is 3/32" laminated paper-base XXXP (MIL-P-3115) Type PBE.—*Precision Metal Products Co., 41 Elm St., Stoneham 80, Mass.*



For more information circle **348** on inquiry card.

IRON POWDER SPUR GEARS

New AGMA commercial class 4 and precision class 1 spur gears up to 1 square inch cross-section are made from pure electrolytic iron powder. Physical properties of most production steels are duplicated through

From DIALCO—New, Compact

OIL TIGHT

INDICATOR LIGHTS

for heavy duty industrial applications

OIL TIGHT
DUST TIGHT
OMNIDIRECTIONAL

Exceptionally Rugged!

Perfect oil-tightness is effected by retained oil-proof gaskets and the gasketed glass lens assembly.

These units have many heavy-duty features: *One-piece solid brass bushing, solid brass lens holder, high impact phenolic insulation, rugged binding screw terminals.*

They install easily in a single 1" or 1³⁄₁₆" panel mounting hole. Other units available for ¹¹⁄₁₆" mounting hole. *A choice of 3 lens styles, 7 lens colors,* and other optional features provide adaptability. If you have an unusual problem, consult our engineering department.

DISCS with legends, behind flat lenses, deliver specific messages.

DIALCO®

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103-3502-1331
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No.
104-3502-XP10—231

Illustrations are approx. actual size

OIL TIGHT INDICATOR LIGHTS

accommodate a wide range of Incandescent and Neon Glow Lamps. For neon, DIALCO offers an exclusive feature — *BUILT-IN RESISTORS* (U. S. Patent No. 2,421,321) for operation on 105-125 V, or 210-250 V. Simple external resistors are provided for all higher voltages. *EVERY ASSEMBLY IS AVAILABLE COMPLETE WITH LAMP.* For design purposes we will send :

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

***CATALOG "L-200"* gives you complete specs on DIALCO'S Oil-Tight Indicator Lights. Also available—a file of Special Catalogs on DIALCO Pilot Lights covering every indication requirement.**

***FREE* — Brochure on *"Selection and Application of Pilot Lights"*.**

Foremost Manufacturer of Pilot Lights

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42 STEWART AVENUE
BROOKLYN 37, N. Y.
HYACINTH 7-7600

DIALIGHT CORP., 42 Stewart Ave., Brooklyn 37, N.Y.

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Company____________________

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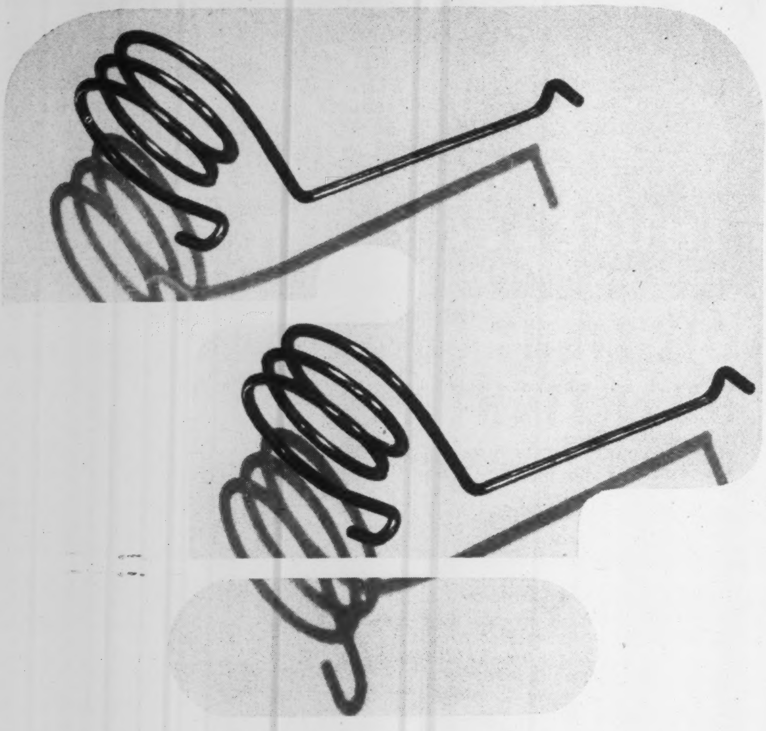
City________________ State__________

For more information circle **115** on inquiry card.



Which Spring Costs More . . . and Why?

■ These springs look identical—and one will work as well as the other, yet one costs more. The higher cost spring was the product of time consuming engineering effort, plus a demand for unnecessary close tolerances and secondary production operations. The other was the simpler, low cost result of Lewis engineering experience and production know-how.

Lewis engineering experience is one of many "extras" you get when you make Lewis your source for springs. Whether it's help in spring design, packaging springs for efficient assembly line handling, or simply a case of getting top quality springs at competitive prices—call on Lewis.

LEWIS SPRING & MANUFACTURING COMPANY
2648 W. North Avenue, Chicago 47, Illinois

Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material

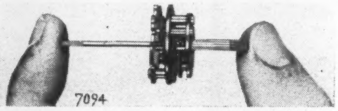
For more information circle **116** on inquiry card.

high compacting pressures and carburizing. Uniform accuracy throughout a production lot is attained through die accuracy. Tooth surface finish is equivalent to a ground finish.—*Supermet Div., Globe Industries, Inc.,* 1466 *Cincinnati St., Dayton* 8, *Ohio.*

For more information circle **349** on inquiry card.

REDUCING GEARS

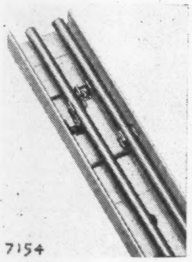
New reducing gear train (300 to 1 in 6 steps) is up to AGMA precision #3. Gears are available in ⅛" to 5"



OD, 16-180 DP.—*H. O. Boehme, Inc.,* 915 *Broadway, New York* 10, *New York.*

For more information circle **350** on inquiry card.

TUBE RACE

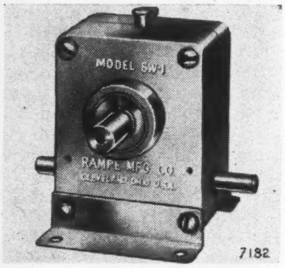


New tube race provides an efficient yet inexpensive method of supporting a limited number of tubes, as in branch runs to and from the main runs of maker's tube-supporting system. It comes in 16' sections, in widths of 1", 1½", and 2½" and is equipped with tube clips spaced at 2' intervals to accommodate ¼" or ⅜" tubes. Connections and changes of direction are made by field cutting and welding.—*Instrof Corp., Collegeville, Pa.*

For more information circle **351** on inquiry card.

SPEED REDUCTION UNIT

New "Model SW-1" for use with FHP motors has case molded from polyester fibre glass, gear made of nylon and worm of steel. Units fill price gap between stamped clock-type gear and heavier cast metal case with cut gears; are available in 7 sizes with speed reductions ranging from 5¼ to 1 to 60 to 1, with solid or hollow shafts.—*Rampe Mfg. Co.,* 14915 *Woodworth Ave., Cleveland* 10, *Ohio.*



For more information circle **352** on inquiry card.

MISCELLANEOUS

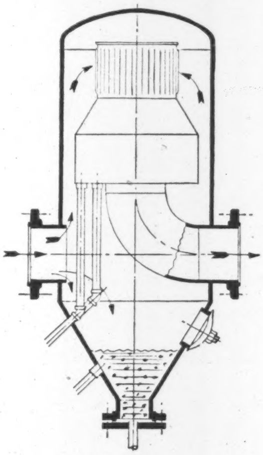
STERILE FILTER

New filter combines (1) cotton packing for removal of micro-organisms from a gas and (2) porous stainless steel filter element which prevents contamination of the stream by lint fibers. It can be packed with the cotton medium, sealed, and sterilized as a unit for use in pharmaceutical operations requiring sterile techniques. Units can be designed to handle large or small gas flows at low pressure differentials; permit use of large areas in small volumes; are fabricated of 18-8 stainless steel, and designed for inline mounting in a piping system.—*Micro Metallic Corp. 30 Sea Cliff Avenue, Glen Cove, N. Y.*

For more information circle **353** on inquiry card.

STEAM RECEIVER-PURIFIER

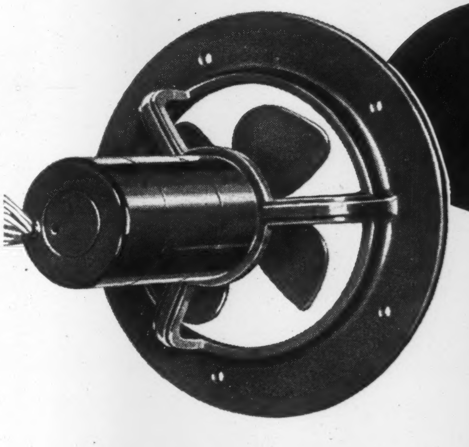
New receiver-type "Hi-eF Purifier" purifies exhaust steam so that it can be reused for heat exchangers, unit heaters, etc. All condensate, oil droplets, and other mist entrainment is intercepted from exhaust steam by means of a new two-stage principle of separation. In first stage, sudden reduction in velocity, combined with correct design of drum, drops out larger droplets. Then a multi-stage separating element removes fine mist by centrifugal action.—*The V. D. Anderson Co., 1945 W. 96th St., Cleveland 2, Ohio.*



For more information circle **354** on inquiry card.

PHOTORECORDING PAPERS

New "Linagraph 483 and 1344" photorecording papers both have emulsions coated on an exceptionally strong ultra-thin base (0.0030" average thickness) providing increased footage per given roll diameter. "1344" is sensitive enough to record a legible trace from an oscillograph galvanometer beam writing at a spot velocity greater than 2,000 ips. "483," for use when extreme emulsion sensitivity is not needed, produces a good



RING-MOUNTED

PRECISION-BUILT

MINIATURE FAN UNITS

400 CYCLE
Variable
Frequency

EAD's ring-mounted fans are designed for quick, easy installation in avionic and electronic equipment. Designed for peak performance, compactness, and versatility, these units utilize blade diameters as small as 2"—with air delivery greater than many heavier blowers. These fan units, using motor sizes from 1" to 2" in diameter, are designed to meet your most rugged conditions. There is a ring-mounted fan for your requirements. Write for complete technical and performance data.

REPRESENTATIVE UNITS

Air Delivery at 0" S.P.	Air Delivery at .5" S.P.	Blade Dia.	Voltage	Frequency	Input (Watts)	Phase Data	Basic Type Numbers
180	145	3⅜"	115	400	90	1	F4H92H
65	30	3"	115	400	15	1	F2HIT
32	15	2"	115	400	10	1	F2H90U

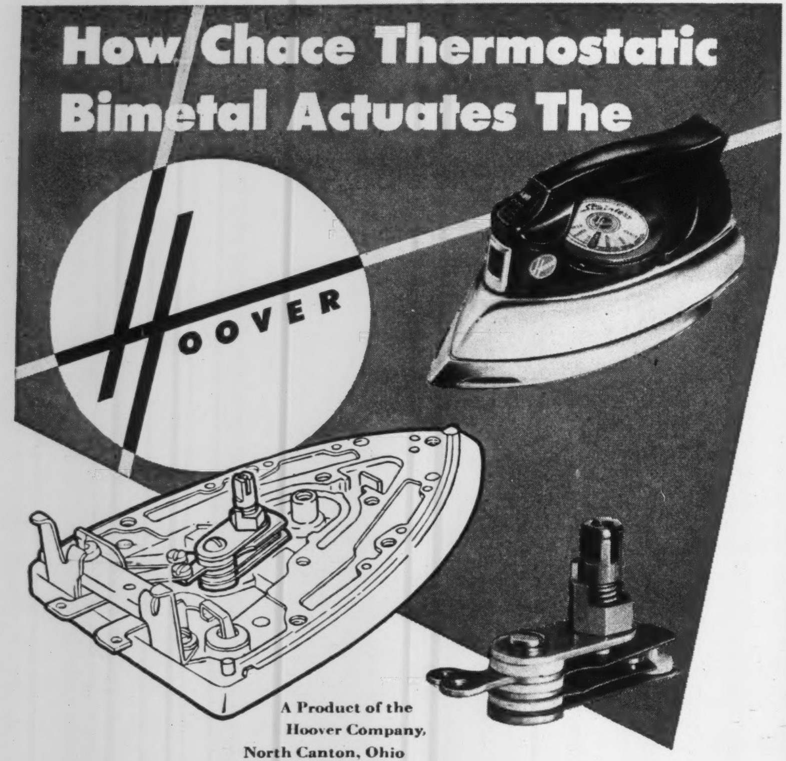
EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS · CENTRIFUGAL BLOWERS · TACHOMETER GENERATORS · FANS · ALTERNATORS · GEAR MOTORS

347 CENTRAL AVENUE • DOVER, NEW HAMPSHIRE

For more information circle **117** on inquiry card.



How Chace Thermostatic Bimetal Actuates The

A Product of the Hoover Company, North Canton, Ohio

STEAM OR DRY IRON
MODEL 013

This new Hoover Model 013 Steam or Dry Iron offers a host of unique features such as a stainless steel sole plate, easy disassembly for descaling of flash chamber, cast-in tubular sheath type heating element and other evidences of progressive engineering. The dial settings for all fabrics, either steam or dry ironed, and the reliable Chace Thermostatic Bimetal element are features users may depend on for safe, fast, faultless ironing.

The various temperature settings are obtained by varying the stress on the contact springs by turning the Safety Set selection dial. The bimetal element deflects as the temperature of the adjacent sole plate increases. When the sole plate reaches the set temperature, the bimetal has bent in the amount necessary to separate the contacts and break the power circuit. The thermostatic bimetal element separates the contacts by pressing against the upper contact spring through a ceramic pin attached to the outer end of the element. As the sole plate cools, the bimetal straightens, permitting the contacts to close, thus completing the power circuit.

Chace Thermostatic Bimetal is available in 29 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal, formulas, calculations, etc.

IT BENDS WITH THE HEAT
W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

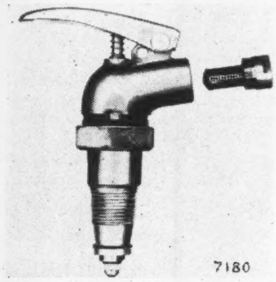
For more information circle **118** on inquiry card.

black trace on a clean white background; can be processed in solution temperatures from 68 to 120°F.—*Eastman Kodak Co., Rochester 4, N.Y.*

For more information circle **355** on inquiry card.

SAFETY DRUM FAUCET

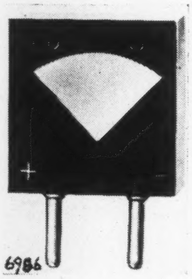
New "leak-proof, self-positioning and self-closing safety drum faucet for safe control of flammable liquids


7180

can be used with any type of container that has a ¾" bung opening. Cylindrical perforated brass flame arrester serves also as a strainer.—*Protectoseal Co.,* 1920 *So. Western Ave., Chicago* 8, *Ill.*

For more information circle **356** on inquiry card.

SILICON PHOTOCELLS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New "Type P-100 Fotosolar" miniature silicon photoelectric cells, 1" square and 9/32" thick, supplement maker's line of silicon solar batteries; feature ability to operate on infrared radiation, rapid response, resistance to moisture, performance at temperatures as high as 150°C., permanent life-time *p-n* junction and enough power to obviate need of amplifiers in some switching applications.—*Hoffman Electronics Corp., Nat'l Fabricated Products Div.,* 2650 *W. Belden Ave., Chicago* 47, *Ill.*

For more information circle **357** on inquiry card.

PHOTOCOPY UNIT

New large "Contoura-Constat" makes immediate copies of drawings or anything else that is drawn, printed, written or typed. This new "Magna Unit" copies up to 14" x 18"; has inflatable cushion similar to that on "Research" and "Legal" units, making it possible to copy from bound books and magazines as easily as from flat documents.—*F. G. Ludwig, Inc., Old Saybrook, Conn.*

For more information circle **358** on inquiry card.

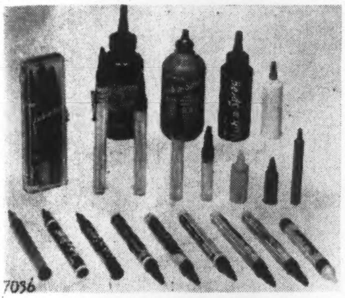
ZOOM LENS FOR ITV

New lens with a zoom range of 6 to 1, 20 to 120 mm focal length, is available only for Industrial TV cameras. Speed, f3.9, is constant over entire zoom range.—*Zoomer, 55 Sea Cliff Ave., Glen Cove, L.I., N.Y.*

For more information circle **359** on inquiry card.

INSERT-PACKAGE LUBRICANTS

New private-label insert-package program serves makers of equipment in which lubrication plays a mainten-

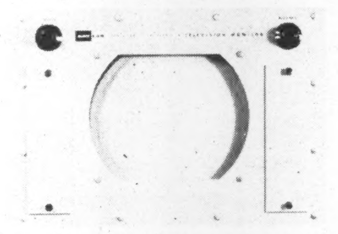


ance role: Lubricant-maker develops and produces specialized lubricants to equipment-maker's specs. Packaging of these lubricants features modern flexible plastic and puffer-type containers imprinted with equipment-maker's trademark in any color scheme.—*Panef Mfg. Co., Inc., Milwaukee 1, Wis.*

For more information circle **360** on inquiry card.

INDUSTRIAL TELEVISION

Newly redesigned "1985" ITV system provides increased sensitivity and reliability for exacting closed-circuit



TV requirements; incorporates removable plug-in subassembly construction pioneered by maker. Basic system comprises small camera weighing less than 5 lb, camera control, and monitor. 10", 17", or 21".—*Kay Lab, 5725 Kearney Villa Rd., San Diego 12, Calif.*

For more information circle **361** on inquiry card.

SERVICEMAN'S TOOLS

Newly expanded electronic tool line is said to "include every conceivable tool required by the electronic service

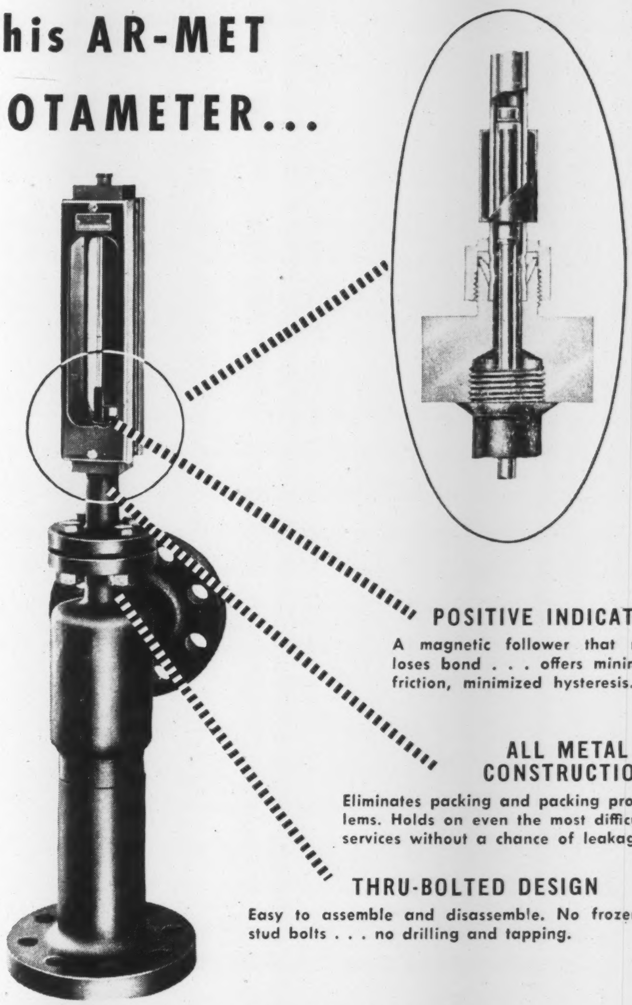
HUNTER TOOLS

man." Tools can be purchased separately or in complete kits in every size "to meet all situations."—*Hunter Tools, Box 564, Whittier, Calif.*

For more information circle **362** on inquiry card.

BROOKS LEADERSHIP *achieved by design*

This AR-MET ROTAMETER...



POSITIVE INDICATION
A magnetic follower that never loses bond . . . offers minimized friction, minimized hysteresis.

ALL METAL CONSTRUCTION
Eliminates packing and packing problems. Holds on even the most difficult services without a chance of leakage.

THRU-BOLTED DESIGN
Easy to assemble and disassemble. No frozen stud bolts . . . no drilling and tapping.

TAKES PRACTICALLY ALL FLUIDS OFF THE "HARD TO HANDLE" LIST

If you're working with highly penetrable fluids . . . high temperatures, high pressures . . . Brooks Ar-Met Rotameters are made to order for you.

The Brooks Ar-Met Rotameter with Mag/Na/Vue indicating extension is shown . . . however, Ar-Met meters are also available with six other alarm and transmission extensions, both electrical and pneumatic. Write for Bulletin 130.

Ar-Met and Mag/Na/Vue are trade-names.

Ar-Met Rotameter Data Available in Bulletin 130.

a complete line... **BROOKS**™ **ROTAMETERS** *...for every service* ®

BROOKS ROTAMETER COMPANY
104 EIGHTH STREET • LANSDALE, PA.

For more information circle **119** on inquiry card.

INSTRUMENTS and AUTOMATION Briefs

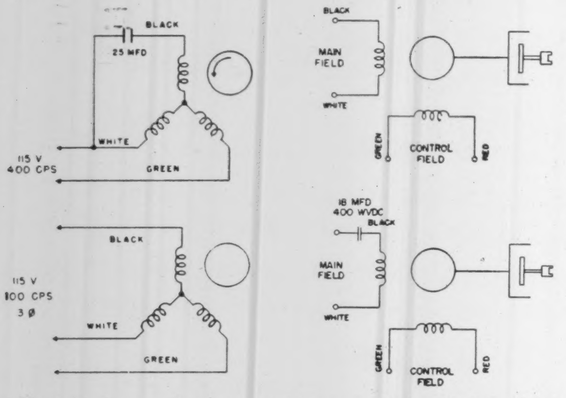
For this literature circle number on inquiry card.

Instrument Motors—Drive and Control

Power output of instrument motors is usually expressed in watts rather than horsepower. Power output is proportional to speed and torque. The conventional equation reduced to watts, rpm and ounce-inches becomes:

$$P = \tfrac{3}{4} \times N/1000 \times T$$

where P = Power in watts; N = Speed in rpm; T = Torque in ounce-inches.



Hysteresis synchronous motors are designed for drive applications requiring constant running speed . . . feature high acceleration and efficiency . . . *Control motors* are two-phase induction motors designed for low inertia and maximum torque at stall . . . used where servo operations are desired.

Control motors are designed to operate from a 2-phase source so that the phase of the voltage across one winding is displaced 90° relative to that of the other winding. *Hysteresis synchronous motors* and drive motors are usually wound to operate from either single, two or three phase supplies . . . the latter two can be made to operate from a single phase supply in conjunction with a phasing capacitor. (*From new* 36-*page Catalog "Instrument Motors and Accessory Equipment," Servomechanims, Inc., Mechatrol Div.,* 625 *Main St., Westbury, N. Y.*)

For this literature circle **401** on inquiry card.

M-S-A Soundscope

An intelligent approach to any noise problem must begin with knowledge of existing noise conditions. The information generally sought includes the overall sound pressure level, the sound pressure level of components in octave bands throughout the audible spectrum, and on occasion, the analysis of levels in bands narrower than whole octaves.

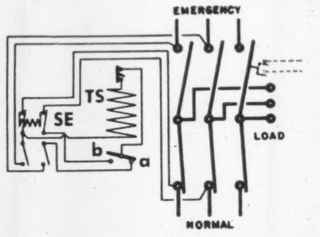
The M-S-A Soundscope measures overall sound level at the microphone over the range of 24 to 150 decibels (re 0.0002 dynes/sq cm). The signal is measured on an averaging-type meter with a range of 16 db. Overall attenuation can be varied through a range of 100 db in 10 db steps.

All amplifier circuits provide essentially flat frequency response from 20 to 20,000 cycles . . . The analyzer section consists of an octave band filter set . . . for measuring sound levels in each of the seven octave bands from 75 to 9600 cycles. (*From new 4-page Bulletin No.* 0818-1 *Mine Safety Appliances Co.,* 201 *N. Braddock Ave., Pittsburgh* 8, *Pa.*)

For this literature circle **402** on inquiry card.

Automatic Transfer Switches

An automatic transfer switch is an electromagnetic control device designed to automatically transfer a load from a normal (or preferred) source to an emergency source upon failure or reduction in voltage of the normal source.



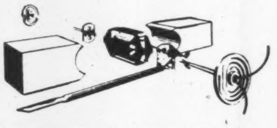
Standard transfer switches will automatically restore the load to the normal source when it is again in proper operating condition, regardless of the condition of the emergency source.

ASCO momentary coil energization principle: On power failure upper contacts on relay "SE" open and lower contacts close. Main coil (TS) is momentarily energized from emergency source. Contact (a) immediately opens coil circuit. Normal power restoration again energizes "SE"; upper "SE" contacts close, momentarily energizing (TS) through contact (b). Switch returns load to normal, and (b) opens main coil circuit. (*From new* 16-*page Publication No.* 596, *Automatic Switch Co.,* 391 *Lakeside Ave., Orange, N. J.*)

For this literature circle **403** on inquiry card.

Panel Instruments

The moving vane type is still the preferred movement for AC measurement . . . Simpson produces a commercially practical and accurate dynamometer panel meter movement . . . the only manufacturer producing a 2" wattmeter.



The New Simpson-Greibach movement offers a completely new adaptation of the D'Arsonval principle—one that eliminates friction due to pivots and jewels because the movement is suspended on fine bifilar wires. (*From new* 6-*page Technical Bulletin No.* 2054, *Simpson Electric Co.,* 5200 *W. Kinzie St., Chicago* 44, *Ill.*)

For this literature circle **404** on inquiry card.

Want control for Water Heaters, Heat Exchangers, Processes?

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FLOWRITE VALVE
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THE POWERS REGULATOR
TO COMPRESS SPRING
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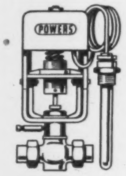
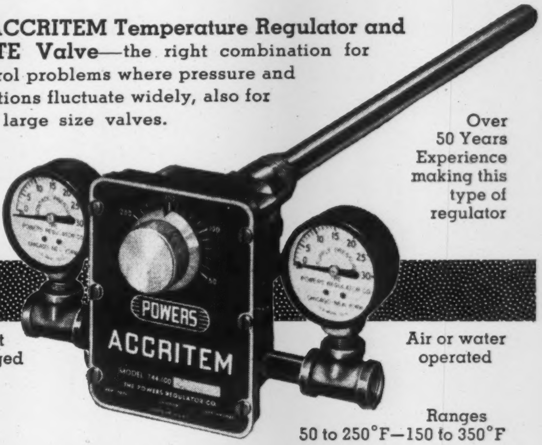


you use the right type regulator and proper size control valve. Whether a simple self-operating regulator shown at left is required or the air operated controls featured here . . . you can get both types and others from Powers. For further information call or write our nearest office.

Powers ACCRITEM Temperature Regulator and FLOWRITE Valve—the right combination for many control problems where pressure and load conditions fluctuate widely, also for control of large size valves.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Control Point easily changed

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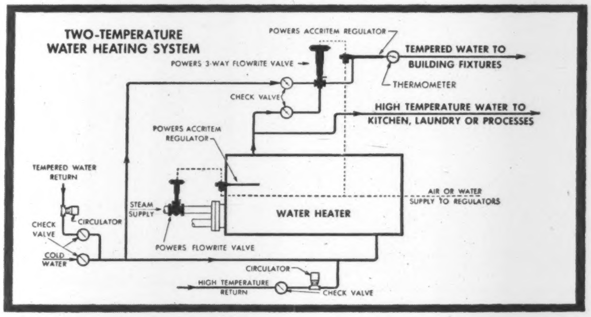
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COLD WATER
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ACCRITEM TEMPERATURE REGULATOR

Gives Close Control and Years of Dependable Service.

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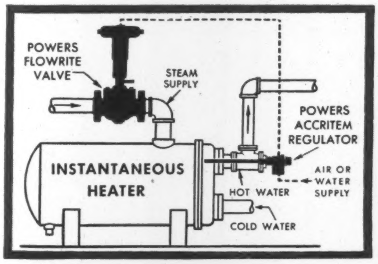
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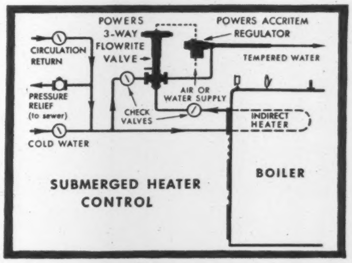
AIR OR WATER SUPPLY
HOT WATER
COLD WATER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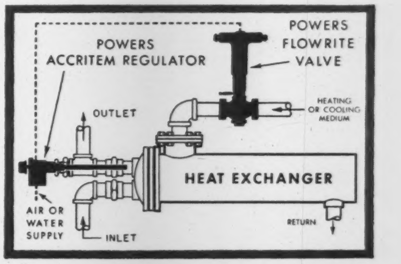
CIRCULATION RETURN
TEMPERED WATER
PRESSURE RELIEF (to sewer)
CHECK VALVES
AIR OR WATER SUPPLY
INDIRECT HEATER
COLD WATER
SUBMERGED HEATER CONTROL
BOILER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For more information circle 120 on inquiry card.

Digital Computer

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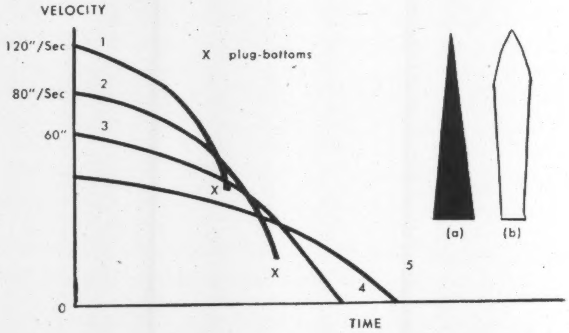
The Differential Equation to be Evaluated by the Litton 20

$$\frac{dx'}{(x')_x} = \frac{\pi b^2 P_1}{M(x')_x}\left(\frac{1}{1-\frac{x}{l_1}}\right)^k dt + \frac{K(x')dx}{M(x')_x\left(1-\frac{y^2}{a^2}\right)^2} + \frac{Wh_2}{M(x')_x}dt$$



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models for every purpose

Whatever your vibration-measurement problem, there's a CEC *self-generating* Vibration Pickup to do the job. Various models are usable from −65° to +500°F . . . in any position and with *absolute* freedom from sticking at low frequencies or amplitudes. For either direct reading on vibration meters or recording through oscillographs, they're ideal for sensing vibration . . . accurately and dependably.

SPECIFICATIONS

Frequency Response . . . . 4-102A . . Flat ±5%, 8-700 cps @ 80°F
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4-118 . . . Flat ±10%, 50-500 cps @ 100°F

Temperature Range . . . . 4-102A . . . . . . 0 to 150°F
4-103 . . . . . 150°F to 250°F
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For complete description, write today for Bulletins CEC-1546A-X9 and CEC-1535B-X17

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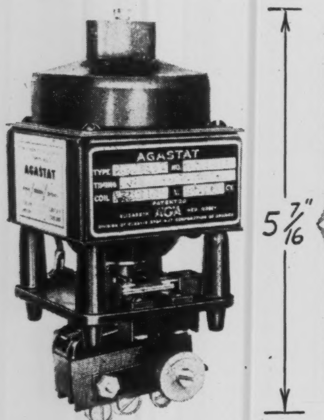
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena California
For more information circle **121** on inquiry card.



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Time / Delay / Relay

AGASTAT allows you to stagger the starting of three motors without imposing their load on the line at the same time.

The AGASTAT is
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- instantaneous recycling.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in AC or DC models which offer delays on energizing and de-energizing, manually-actuated time delay switch, remote push button control, hermetically-sealed units.

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MODELS AT $21.95 TO $26.95

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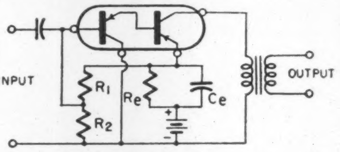
formed with respect to any chosen variable instead of with respect to the independent variable only.

A typical problem in mechanical engineering is the design of a shock absorber . . . The tables and charts show the variables, parameters, basic equations, and final plug shape chosen after examining curves. (*From new 12-page booklet "Announcing a new Concept in Electronic Computing," Litton Industries, 336 North Foothill Rd., Beverly Hills, Calif.*)

For this literature circle **405** on inquiry card.

Tandem Transistors

Housed in a single case, two d-c coupled transistors now open an entirely new field for use as oscillators, multivibrators, flip-flops, switching devices, etc. They are not used as mere dual transistors, but as a two-stage cascade. A common-collector transistor stage acts as the input device of a second transistor to serve as a useful type of dc matching transformer. No extra power supply is required since the first transistor represents the base leak for its successor. (*From new 4-page bulletin "Tandem Transistors," Mar Velco Electronics Div., National Aircraft Corp., 3411 Tulare Ave., Burbank, Calif.*)



For this literature circle **406** on inquiry card.

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The Hays Combustion Meter operates on the Orsat principle of volumetric measurement and chemical absorption

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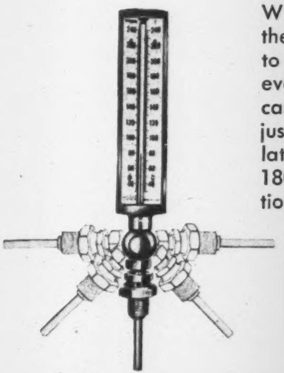

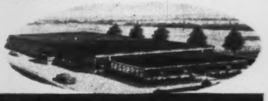

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DIETERT-DETROIT MOISTURE TELLER

Determine the moisture content of any material quickly, easily and accurately with the modern, low priced Dietert-Detroit Moisture Teller. Direct testing method . . . no chemicals, calibrations or involved computations necessary. Ideal for research, analysis and control work.

See How Dietert-Detroit Moisture Tellers Speed up Testing Time!

Sample	Sample Size Grams	Temp. Degs. F.	Drying Time Min.
Sand	50	250	3
Paper	50	250	15
Salt	20	260	6
Soap	10	250	9
Color Pigment	10	212	12
Liquid Wax	5	250	15
Yeast	50	280	15
Licorice Extract	5	220	30
Pig Meal	25	250	25
Mash Pellets	25	255	25
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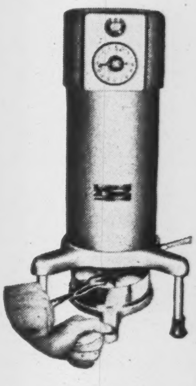

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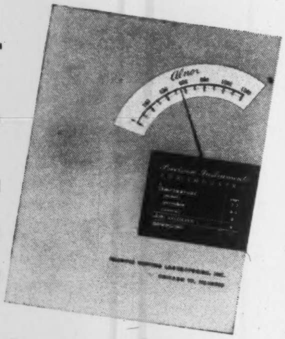

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Here, in one handy file, are illustrations and complete information on the more than 20 types of Alnor instruments designed for measuring air velocities, temperatures and dew points.

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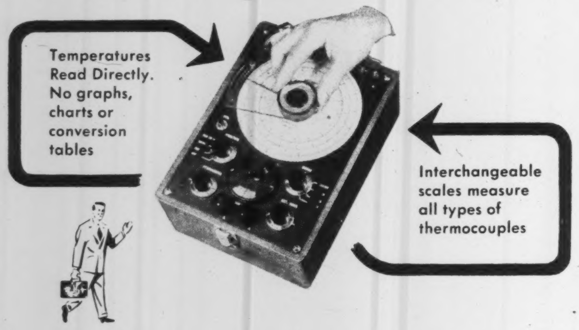
Temperatures Read Directly. No graphs, charts or conversion tables
Interchangeable scales measure all types of thermocouples

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"Pyrotest" is the most versatile instrument of its type. Compact, rugged, easy to carry (12 lbs. . . . 12¼" x 9" x 8½"). Accurate to ¼ of 1%. 5 instruments in one—with a scale for every use, interchangeable in 30 seconds. Self-contained power supply. Write for free Bulletin 112.

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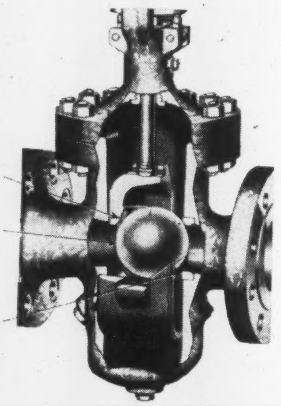
For more information circle **128** on inquiry card.

BRIEFS—CONTINUED

. . . A sample of flue gas is automatically measured at a constant pressure. It is then directed into an absorption burette where the CO_2 content of the sample comes in contact with an absorbing chemical, Hays Cardisorber. In absorbing the CO_2, liquid Cardisorber is displaced in an inverse proportion to the CO_2 content of the gas sample. The CO_2 content is then recorded on a ten-inch chart at the end of each analysis, which is about every two minutes. (*From new 4-page Publication* 56-553-1, *The Hays Corp., Michigan City, Ind.*)

For this literature circle **407** on inquiry card.

Paul Venturi Ball Valve



P-K Paul Valves are based on the Bernoulli Theoren that pressure in any fluid stream is higher in the lov velocity area than at th high velocity center. Thi is the principle that give lift to wings and is th basis of flow measurement and jet pumping . . The ball disc and sea design provides absolut tight shut-off. In addition, since the ball presents a continually nev seating surface, valve lif is increased greatly.

The C_v ratings listed indicate the exceptionall high capacity . . . . Th P-K Paul valve capacitie approach the flow valve of Venturi gate valve design . . . The flow

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Always the best of the better gauges, Mastergauge has been given *plus* features that further lengthen its lead.

A still better tube construction: Socket, tube and end piece are now all fused into *one* leak-tight unit by the new Marsh "Conoweld" process.

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Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alt

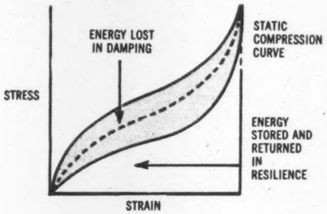
For more information circle **129** on inquiry card.

characteristic of the P-K Paul Valve is essentially linear over the complete stroke. This flow pattern in combination with long strokes and liberal gradients provides a minimum rangeability or "turn down" of 100 to 1 for all valve sizes, plus greater stability without hunting or cycling. *(From new 20-page catalog "Manual and Automatic Valves for The Tough Jobs," P-K Industries, 27 Porete Ave., North Arlington, N. J.)*

For this literature circle **408** on inquiry card.

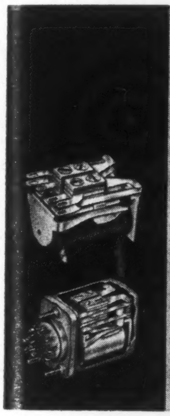
Rubberized Hair

Packaged products are damaged by shock or vibration. Shock is a sudden change in the direction of velocity of the motion of a product . . . The intensity or degree of shock is expressed as rate of change of the product's velocity, measured in ft/sec/sec or G's (one G = 32.2 feet/sec/sec).



Vibration is a motion repeating periodically . . . To prevent damage, cushioning must be selected on the basis of the properties controlling its performance: (1) compression resistance, (2) efficiency, (3) cushion factor, (4) drift, (5) set, (6) damping, (7) resilience, (8) dusting, (9) corrosion, (10) fungus resistance, (11) effects of moisture, (12) temperature. *(From new 12-page booklet, B. F. Goodrich, Sponge Products Div., Shelton, Conn.)*

For this literature circle **409** on inquiry card.



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High volume production with absolute uniformity

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For more information circle **131** on inquiry card.

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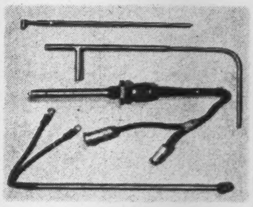

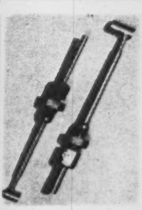

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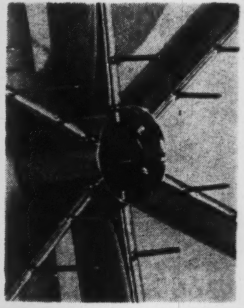
HOT OR COLD

Your test conditions and date requirements guide our specifications.



PROPULSION DEVELOPMENT LABORATORIES
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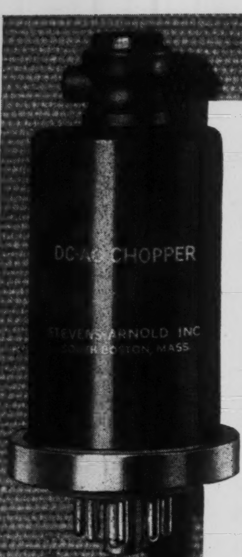
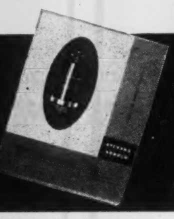
El Segundo, California

For more information circle **132** on inquiry card.





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Built to rigid commercial specifications.

Twenty-two types, both single and double pole.

Long life.

Low noise level.

Extreme reliability.

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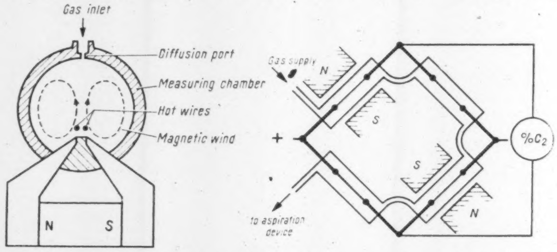
For more information circle 134 on inquiry card.

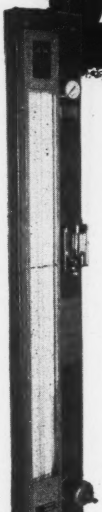
Magnetic Oxygen Meter

Among the industrially important gases oxygen alone is strongly paramagnetic while the other gases are diamagnetic. From this property of the oxygen molecule, the following method for measuring the oxygen content of a gas mixture was derived.



A powerful permanent magnet maintains within a chamber of nonmagnetic material an inhomogeneous magnetic field. Within the range of the highest field intensity an electrically heated wire is stretched. In the presence of oxygen a gas circulation termed "magnetic wind" is produced whose speed depends on the oxygen concentration. The magnetic wind cools the hot wire thereby reducing its electric resistance in accordance with the oxygen content of the gas. Four such hot wires—two with and two without magnet—are combined to form a Wheatstone bridge. When oxygen content is zero the Wheatstone bridge is balanced. As oxygen content rises the Wheatstone bridge gets increasingly out of balance. The moving coil indicator of the bridge indicates this unbalanced condition and is directly calibrated in % O_2. *(From new 4-page Bulletin "Magnetic Oxygen Meter Oxymat," Siemens New York, Inc.,* 350 *Fifth Ave., New York* 1, *N. Y.)*

For this literature circle 410 on inquiry card.



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SERIES 1400
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ACCURATE and EASY TO INSTALL.

Available in 4 Models, Petrometer Series 1400 Tank Gauges operate on the sound principle of hydrostatic pressure. No moving parts, no expensive electrical or electronic equipment. Large vertical scale gives accurate, easy-to-see reading. And construction features make installation easy.

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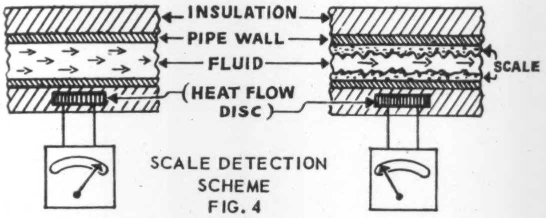
For more information circle 135 on inquiry card.

Heat-Flow Discs

The N.I.L. heat-flow transducer is a thin disc of material containing a thermocouple assembly which produces an electrical output proportional to the flow of heat through the transducer. Since the disc is thin its thermal resistance is low and the disc itself does not materially change the temperature distribution or the flow of heat through the surface with which it is in contact. (*From new 2-page brochure, National Instrument Laboratories, Inc.,* 6108 *Rhode Island Ave., Riverdale, Md.*)



SCALE DETECTION SCHEME
FIG. 4

For this literature circle **411** on inquiry card.

Protective Relays

A protective relay may be compared to an insurance policy which pays off when something unexpected happens—provided the premiums are paid. To be 100% effective, protective relays must have their premiums paid by planned preventive maintenance. Planned periodic testing can save many times its cost by reducing outages and consequent lost revenue.

Components normally used for common relay testing are: (1) instruments of multi-range design of switchboard or better accuracy, (2) timer with a scale in seconds, (3)

AUTOMATIC CONTROL with Contact Meter-Relays

Meter-Relays, VHS Relays, Simplytrol and Versatrol Automatic Controls, Panel Meters and Indicating Pyrometers

40 PAGE ASSEMBLY PRODUCTS CATALOG 4-A

Contents include:

"Circuitry"—6 pages of diagrams and text, including response time tables and discussion on non-locking contacts.

Ordering information.

Prices and detailed specifications for:
Clear plastic, black bakelite and ruggedized-sealed styles of:
  Meter-relays
  Indicating meters
  Indicating pyrometers
VHS Relays
Plug-in relays, power supplies
Automatic pyrometers
Automatic control packages and components
Bearing monitors
Oven pyrometers and millivoltmeters
Kiln pyrometers
Shunts
Transformers

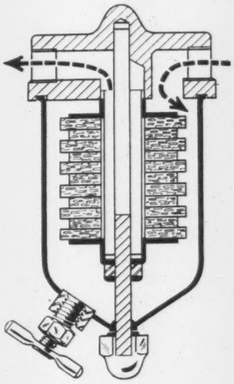
Write for Catalog 4-A.

Assembly Products, Inc.
Chesterland 10, Ohio
HAmilton 3-4436

(West Coast: Desert Hot Springs 10, Calif. Phone 4-3133).

Meter-relays provide control of mechanical operations or chemical processes through alarm and automatic shut-off, or continuous on-off control. Applications include: Bearing temperature alarm and shut-off on pumps, turbines, generators. Automatic speed controls for machines and conveyors. Computer shut-off if power supply voltage varies. Warning and control in radiation measuring equipment and processes. Automatic switching of standby equipment in microwave communications. Continuous control of pH. Signal detection in radar warning systems.

For more information circle **136** on inquiry card.



NEW MICRONIC FILTER FOR INSTRUMENT AIR

A new micronic air filter that provides extremely clean air in small volumes is now available from Air-Maze. The micron size retention efficiency is 90% for particles of .7 micron; correspondingly higher efficiency for larger particles. The filter uses extended area felt discs for fine particle filtration. Manufactured for pipe sizes from 1/8″ to 1″, designed to operate up to 150 psi.

The new Air-Maze micronic filter can be quickly dissembled. The felt discs are cleanable. And the housing has a petcock for removing any collected liquid. For additional information write for data on the Air-Maze H9S filter.—*Air-Maze Corporation,* 25000 *Miles Road, Cleveland* 28, *Ohio.*

(*Advertisement*)

For more information circle **137** on inquiry card.

Berkeley news notes

free data file

"Analog Computer Solutions for Feedback Systems"

by Charles H. Single

Presented at the Fall Conference, American Society of Mechanical Engineers, San Francisco Section, San Francisco, October 28, 1955

Data File 123

Presents typical analog computer techniques in feedback system design. Cites as examples methods used in the design of a nuclear reactor power plant, and of a petroleum fractionating tower system.

Covers the capacity, limitations and practical applications of analog computers to the solution of feedback system design problems.

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Berkeley
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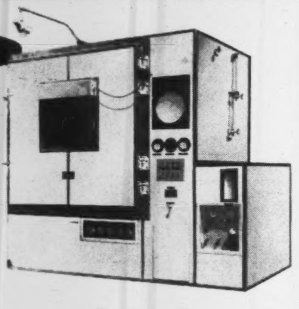
For more information circle **138** on inquiry card.

DEVELCO



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To meet
MIL-E-5272
and others.

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GERMANIUM
INDIUM ANTIMONITE
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MICA, SYNTHETIC
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*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

*Carried in stock
**Purchased for orders

For more information circle **140** on inquiry card.

BRIEFS—CONTINUED

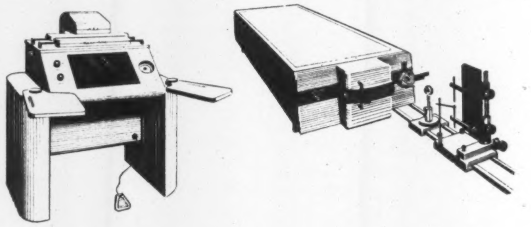
variable voltage source for voltage relays, (4) loading device. Two means of obtaining a current load are used: the resistance load box and loading transformer.

MULTI-AMP units are available from 0.4 KVA to 60 KVA to test a wide variety of electrical equipment. In addition to protective relays, this includes current transformers, instruments, thermal devices, circuit breakers, conductors, etc. . . . (*From new 4-page Data Sheet 156UB, Multi-Amp Corp.*, 10 *Third St., Newark, N. J.*)

For this literature circle **412** on inquiry card.

Spectrographic Analysis

In quantitative analysis a selected wavelength line fron a sample's base element is compared with one from th constituent element to be determined. Therefore, durin excitation, each element must emit its characteristic wave lengths with intensity proportional to the quantity presen . . . The density (blackening) of each line image on th film is proportional to the light emitted by each element These lines are measured by their light transmittancy (T . . . Use the transmittancy readings for each sample t



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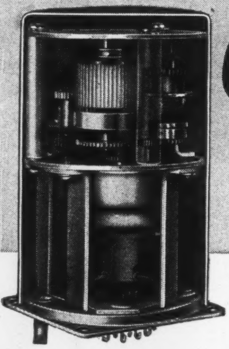
SPECIAL SERVICE CONDITIONS?



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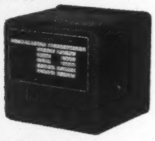
HERMETICALLY SEALED

- **TIME DELAY RELAYS**
- **CYCLING TIMERS**
- **CIRCUIT RECLOSING RELAYS**



- Meet stringent military specifications.
- High accuracy. Long service life.
- Available 50, 60, 400-cycle to 250V AC; 6-30V DC.
- Small size. Precision built.
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- Send for comprehensive technical Bulletin PB-41C

SPECIALISTS IN TIME CONTRO

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18CR56

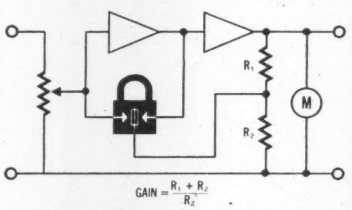
For more information circle **141** on inquiry card.

get each intensity ratio from the film calibration curve. With these intensity ratios and the known concentrations construct the analytical working curve. Then use the intensity ratio of the unknown to get its concentration from this curve. (*From new folder "Quantitative Spectrographic Chemical Analysis," National Spectrographic Laboratories, Inc.,* 6300 *Euclid Ave., Cleveland* 3, *Ohio.*)

For this literature circle **413** on inquiry card.

Microvoltmeter

The KAY LAB DC Microvolt-Ammeter and Amplifier, Model 203, consists of an input divider followed by a chopper amplifier and a two-stage direct-coupled meter driver amplifier. The chopper converts the DC input signal into an AC carrier signal which is amplified by an RC coupled amplifier. The output of this amplifier is rectified by a synchronous detector. This rectified signal is filtered with an RC network and applied to the DC amplifier. Lowest range is 0-100 uv with input impedance of 10 megohms; highest range is 0-100 v with input impedance of 100 megohms. Current ranges from 0-100 uua to 0-100 ma. (*From new 2-page leaflet, Kay Lab,* 5725 *Kearney Villa Rd., San Diego* 12, *Calif.*)



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New IMPERIAL Nylo-Seal™ Tube Fittings

The Economical Corrosion-Resistant Fittings of DuPont "Zytel" (Nylon)

. . . for use with Stainless Steel, Nylon, Polyethylene and other tubing.

Ask for Bulletin 3049

Nylo-Seal Fittings save up to 90% in fitting costs as compared to stainless steel fittings. Also effect substantial savings in installation time.

Excellent for instrument, lubricant, air, hydrocarbon fuel, oil, coolant and low pressure hydraulic lines, food processing, laboratory, chemical and many other applications. Fittings available in sizes ¼" to ½" O.D.; Nylon Tubing in sizes ⅛" to ⅜" O.D.

Withstands temperatures from —70° to +250°F.
Withstands working pressures of 250 psi. at temperatures to 120°F.
Resistant to most acids and alkalies.
Cuts installation time . . . no flaring.

See Your Imperial Industrial Distributor

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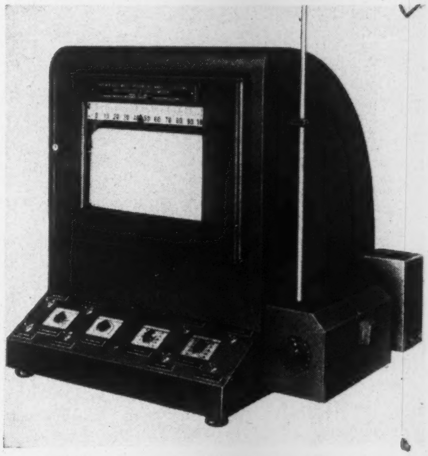
IMPERIAL *Industry's Most Complete Line of Tube Fittings and Tubing Tools*

For more information circle **142** on inquiry card.

Automatic Recording—Mass Collecting Differential Refractometer

Limiting sensitivity 3 x 10⁻⁶



The recorder pen indicates refractive index difference. The recorder chart movement is controlled by the mass (volume) of sample passed. A valuable instrument for qualitative and quantitative analysis.

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For more information circle **143** on inquiry card.

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ROLL TEST THEM RAPIDLY ACCURATELY with the

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So economically priced they can be placed alongside each Gear Cutter as well as in the Inspection Dept.

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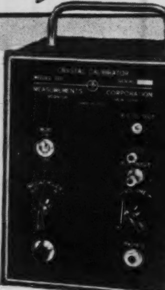

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CRYSTAL CALIBRATOR

For calibration and frequency checking of signal generators, transmitters, receivers, griddip meters, and other equipment where a high degree of frequency accuracy is required.

Frequency Range
Model 111 - 250 Kc to 1000 Mc
Model 111-B-100 Kc to 1000 Mc

Frequency Accuracy ±0.002%

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MEASUREMENTS CORPORATION
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TORQUE MANUAL
TORQUE WRENCH

Over 85% of the torque wrenches used in industry are

STURTEVANT TORQUE WRENCHES
Read by Sight, Sound or Feel.

- **Permanently Accurate**
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- **Faster—Easier to use**
- **Automatic Release**
- **All Capacities**

in inch grams...inch ounces,..inch pounds ...foot pounds (All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

P. A. STURTEVANT CO
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For more information circle **146** on inquiry card.

INSTRUMENTS and AUTOMATION New Literature

AUTOMATION

Steam Plant Instrumentation. New 6-page reprint "Instrumentation of a New Steam-Generating Facility" describes combustion controls for steam plant of 400,000 lb. per hour capacity at 825 psig and 825°F.—Hagan Corp., Hagan Bldg., Pgh. 30, Pa.
Circle **415** on inquiry card.

Power Generation Instrumentation. New 36-page Bulletin 9070 describes instruments for electrical power generator stations. Includes instrumentation of steam turbines, hydro turbines, diesel engines, gas engines, gas turbines, and electrical distribution systems. — Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.
Circle **416** on inquiry card.

Control Systems. New 20-page Catalog D-31 presents maker's automation components and "Atcotran" control systems for measurements of displacement or minute motions, electric transmission of variables, etc. Also discusses motorized valves, time control systems, etc.—Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa.
Circle **417** on inquiry card.

Process Control. New 4-page Bulletin A127 describes maker's "Metagraphic" pneumatic process control systems for temperature, pressure, flow, etc.—The Bristol Co., Waterbury 20, Conn.
Circle **418** on inquiry card.

"Electr-O-Volt" Control. New 2-page Specification Sheet S152-2 describes "ElectroniK" instruments with "Electr-O-Volt" proportional control based on saturable-reactor control of electrical power to load.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.
Circle **419** on inquiry card.

Process Control. New 64-page Bulletin P1245A describes maker's line of process control instruments based on "Dynamaster" high-speed, continuous-balance, null-type potentiometers and bridges. Includes pneumatic and electric controllers, digital outputs, etc.—The Bristol Co., Waterbury 20, Conn.
Circle **420** on inquiry card.

Chlorinator Control. New 4-page bulletin M-57-S presents maker's new V-notch variable-orifice chlorinator.—Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.
Circle **421** on inquiry card.

Hydraulic Regulator. New 4-page Bulletin 165 describes maker's "Powerpack," a self-contained hydraulic regulator that combines pump and cylinder in one unit.—Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.
Circle **422** on inquiry card.

Human Engineering. New 20-page brochure describes human engineering systems analysis to determine man-machine relationships for improved output efficiency.—Crosley Div., AVCO Mfg. Corp., Cincinnati 15, Ohio.
Circle **423** on inquiry card.

Automatic Assembly. New 12-page brochure describes maker's automatic assembly machine for multi-component assemblies such as locks, relays, bearings, etc.—Multra Corp., Stamford, Conn.
Circle **424** on inquiry card.

Automatic Assembly Equipment. New 4-page bulletin describes maker's automatic and semi-automatic production assembly machinery for electronic components.—Industrial Sales Div., United Shoe Mach. Corp., 140 Federal St., Boston 7, Mass.
Circle **425** on inquiry card.

VALVES

Magnetic and Motorized Valves. New 20-page Catalog V-55 presents magnetic and motorized valves for use with air, water, gas, steam, oil and refrigerants.—The Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.
Circle **426** on inquiry card.

Solenoid Valves. New 18-page Catalog 200 describes solenoid valves for air, gas, liquids, and steam.—Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis 25, Ind.
Circle **427** on inquiry card.

Boiler Level Gages and Valves. New 2-page Data Sheet 237 describes maker's electrically heated gages and valves.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.
Circle **423** on inquiry card.

Control Valves. New 4-page Bulletin 115 describes maker's air operated control valves for chemical, petroleum and process industries.—Uniflow Valve Corp., Cranford, N. J.
Circle **429** on inquiry card.

Valves. New 4-page bulletins present characteristics on maker's line of "Shear Seal" valves: Bulletin 5S-H solenoid-operated oil valves; Bulletin 5S-A, solenoid-operated air valves, Bulletin 5S-W, solenoid-operated water valves; Bulletin O-5, manually-operated oil valves; Bulletin A-5, manually- and foot-operated air valves; Bulletin 5-D.P., manually-operated dual pressure valves; also bulletin on manually operated water valves.—Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle **430** on inquiry card.

PVC Valves. New 6-page Bulletin 601 presents installation data, dimensions and chemical resistance table for maker's new, all-molded, corrosion-resistant, "PVC" valves and fittings.—Lunkenheimer Co., Cincinnati 14, Ohio.

Circle **431** on inquiry card.

Safety Cleanout Valve. New 6-page Bulletin 4000-1515 describes maker's safety cleanout valve for buried tank storage of volatile, inflammable liquids.—Petrometer Corp., 43-22 10 St., Long Island City 1, N. Y.

Circle **432** on inquiry card.

Solenoid-operated Valve. New 2-page bulletin describes maker's new two-way, solenoid-operated shut-off valve for 3,000 psi service.—Aircraft Products Co., 300 Church Rd., Bridgeport, Pa.

Circle **433** on inquiry card.

Pumps, Valves. New 4-page Bulletin A 5200-D describes maker's line of airborne oil-hydraulic components and systems.—Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.

Circle **434** on inquiry card.

MOTORS

DC Motors. New 4-page Catalog F-4344-3 describes maker's line of fractional-hp, permanent-magnet, dc motors; also gearheads, centrifugal blowers, and tachometer generators.—Barber-Colman Co., Rockford, Ill.

Circle **435** on inquiry card.

Special Motors. New 12-page Catalog No. 54-PD describes maker's facilities for specially designed motors, generators and other rotating electrical equipment.—Electric Specialty Co., 211 S. St., Stamford, Conn.

Circle **436** on inquiry card.

Servo Motors. Four new catalog sheets (10-5055-13, 10-5051-08, 10-50-52 and 15-5153) present data on maker's low-inertia servo motors.—John Oster Mfg., Co., Avionic Div., Racine, Wisc.

Circle **437** on inquiry card.

Motors. New 4-page issue of "The Bodine Motorgram" (Vol. 36 No. 2) features special-purpose mountings and application of maker's motors in remote servo control of TV cameras.—Bodine Electric Co., 2282 W. Ohio St., Chicago, Ill.

Circle **438** on inquiry card.

Motor Laminations. New 4-page Bulletin 563 presents importer's laminated stators, rotors, fields, armatures and pressure die-cast rotors.—Laminations Co., 300 Main St., Stamford, Conn.

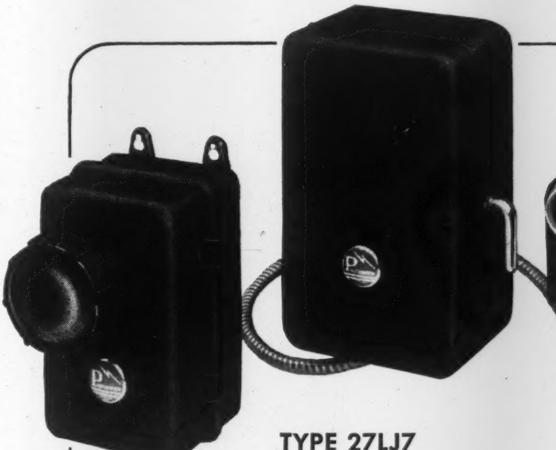
Circle **439** on inquiry card.

Motor Controller. New 2-page Bulletin 10-025 presents maker's "LC Servo-Amp" that provides automatic correction when motor load changes.—Control Engineering Co., 8900 Altine Ave., Detroit 4, Mich.

Circle **440** on inquiry card.

NEW **HIGH SENSITIVITY**

PHOTOELECTRIC CONTROL



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Long Range Detection
Density Control
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and many other operations

HERE IS THE UNMATCHED ANSWER for those applications where fast positive control must be based on small changes in light intensity.

SENSITIVITY of this new instrument is so high that its relay will operate on a received-light intensity of 0.05 foot-candle . . . about the amount of light received from a candle at 20 feet.

OPERATING DIFFERENTIAL is 0.02 foot-candle . . . with constant-voltage light source supply the control will detect the presence or absence of clear water in an ordinary tumbler through which the light beam passes.

RELIABILITY rests on the use of top-quality components, operated well below their ratings, and engineered into a circuit incorporating the latest techniques of electronic design.

Standard models available with meters and recorders — scanner available with adjustable iris diaphragm which provides precise control of the amount of received light. Extended lens system for light source and receiver can be supplied for operation over long distances. For full details write for Bulletin PA 561.

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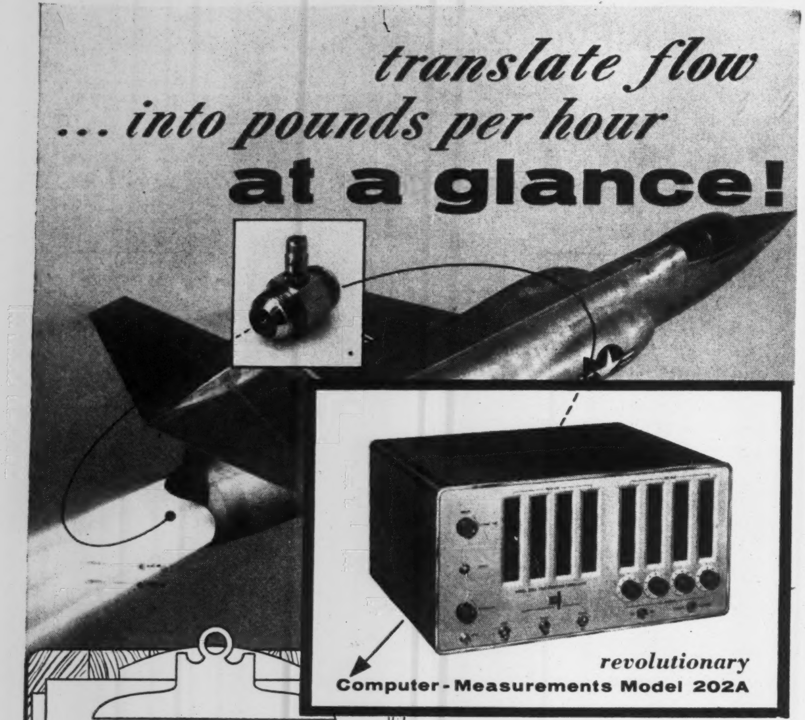

revolutionary
Computer-Measurements Model 202A

TIME-FUNCTION TRANSLATOR

Applications:

- ✓ Gallons per minute ... into Gallons per hour
- ✓ Gallons per minute ... into Pounds per hour
- ✓ Pulses per second ... into Gallons per minute
- ✓ Total Count of Gallons or Pounds
- ✓ Tachometer Applications
- ✓ Direct Frequency Measurement
- ✓ Many Others

Translating flow into weight as required for jet engine analysis is just *one* of the *many* uses for the *all-new* Model 202A TIME-FUNCTION TRANSLATOR. The 202A permits *instant* direct read-out of unknown quantities by translating one function of time into another function of time. It eliminates the need for conversion tables, graphs, charts, etc. The variable time base display may be illuminated or blanked at operator option. The versatile 202A fills a long recognized need in electronic measurement.

Write for complete information and detailed specifications on the Model 202A Time-Function Translator TODAY...

SPECIFICATIONS:

Frequency Range:	1-100,000 cycles per second 0-100,000 positive pulses per second
Input Sensitivity:	0.05 volt rms: 10-100,000 cps (5 millivolts optional) 0.07 volt rms: 1-10 cps Positive pulse rise time: ½ volt or more per sec.
Input Impedance:	0.5 megohm and 50 mmf.
Accuracy:	± 1 count ± stability
Stability:	Short Term: 1 part in 1,000,000 Long Term: 5 parts per million per week
Time Bases:	0.001 to 10 seconds in 1 millisecond steps 0.0001 to 1 second in 0.1 millisecond steps (0.0001 to 10 sec. in 0.1 millisec. steps, 0.001 to 100 sec. in 1 millisec. steps optional)
Read-Out:	Direct. Four digits. (Five digits optional)
Display Time:	Automatic: Continuously variable, 0.1 to 10 sec. Manual: Until reset
Power Requirements:	117 volts ±10%, 50-60 cycles, 250 watts (50-400 cycles optional)
Dimensions:	17" W x 8¾" H x 13½" D
Weight:	35 lbs. net.
Finish:	Panel: Light grey baked enamel Case: Dark grey baked enamel
	Data Subject to Change Without Notice

CMC

*Model FL Flow Pickup: Courtesy—Waugh Engineering Co., Van Nuys, Calif.

Formerly a Division of Detectron Corporation

Computer-Measurements Corporation

5528 Vineland Avenue, North Hollywood, Calif. Dept. 80-F

CC-1B

For more information circle **149** on inquiry card.

NEW LITERATURE

Electric Motors. New 12-page Catalog RB-400 presents maker's complete line of fractional-hp motors, Mono-Motors, blowers, etc.—Redmond Co., Inc., Owosso, Mich.

Circle **441** on inquiry card.

TEMPERATURE

Thermistors, Pressure Gages, Capacitors. New 12-page Bulletin 256 illustrates products of five associated companies—thermistors, power supplies, transducers, accelerometers, capacitors, packaged circuits, ultrasonic equipment, meters and connectors.—Gulton Industries, Inc., Metuchen, N.J.

Circle **442** on inquiry card.

Thermistors, Magnets. New 12-page bulletin DMPM-56-1 presents design data on maker's permanent magnets, cemented carbides, thermistors, "Hevimet" shielding, and vacuum-melted metals.—Carboloy Dept., General Electric Co., Detroit 32, Mich.

Circle **443** on inquiry card.

Thermistors, Varistors. New 20-page Technical Catalog V202 describes maker's thermistors, varistors and assemblies. Also combustion analyzer and hypsometer.—Victory Engineering Corp., Springfield Rd., Union, N.J.

Circle **444** on inquiry card.

Thermistor Mounts. New 6-page issue of "PRD Reports" (Vol. 4 No. 4) features article on improved thermistor mount designs.—Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

Circle **445** on inquiry card.

Pyrometers. New 2-page bulletin GEC-1324A presents specifications and applications for maker's pyrometers and resistance thermometers. —General Electric Co., Schenectady 5, N. Y.

Circle **446** on inquiry card.

Thermocouples. New 12-page Bulletin 1S-1-56 provides instructions for use of swaged MgO for thermocouples.—Aero Research Instr. Co., Inc., 1040 W. Grand Ave., Chicago 22, Ill.

Circle **447** on inquiry card.

Temperature Control. New 2-page Data Sheet 620(2) describes maker's temperature control for high-frequency induction heating.—Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Circle **448** on inquiry card.

Cooling Process. New 2-page Data Sheet 3.0-7 describes "Gayvac" process for pre-cooling produce without ice or conventional refrigeration —Industrial Div., Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

Circle **449** on inquiry card.

Low-Temperature Radiation Pyrometer. New 2-page Bulletin Sh391 presents new radiation pyromete for surface temperatures fron 1100°F to below freezing.—Siemens &Halske, Siemens New York Inc., 35 Fifth Ave., New York 1, N. Y.

Circle **450** on inquiry card.

Thermostatic Mixer. New 4-page Bulletin 362 describes maker's nev water temperature control that shut off automatically when hot or cold supply fails.—The Powers Regulator Co., 3434 Oakton St., Skokie, Ill.

Circle **451** on inquiry card.

Thermometer. New 4-page illustrated Bulletin T5 describes maker's stainless steel dial thermometer.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle **452** on inquiry card.

Temperature Indication Liquids. New 1-page Bulletin 5010L presents maker's "Tempilaq" that melts at a specific temperature.—Tempil Corp., 132 W. 22 St., New York 11, N. Y.

Circle **453** on inquiry card.

Thermocouple Circuit Restorer. New 8-page Catalog R-26 describes maker's thermocouple circuit "Restorer" for renewing proper electrical conductivity through thermocouples and thermocouple circuits.—The Peerless Electric Co., Electronics Div., W. Market St., Warren, Ohio.

Circle **454** on inquiry card.

Temperature Control. New 4-page illustrated Bulletin C-256 describes maker's complete line of outdoor-type automatic heat controls for buildings.—Automatic Devices Co., Inc., 714 Hillgrove Ave., Western Springs, Ill.

Circle **455** on inquiry card.

Thermocouples, Pyrometers. New 8-page folder describes portable pyrometers, thermocouples and electrically heated platens for plastics presses.—Hydraulics Div., Wabash Metal Products Co., Box 305, Wabash, Indiana.

Circle **456** on inquiry card.

Cooling Blowers. New 4-page Bulletin 800B describes maker's line of small blowers for cooling electronic equipment.—Trade-Wind Motorfans, Inc., 7755 Paramount Blvd., Rivera, Calif.

Circle **457** on inquiry card.

PRESSURE, WEIGHT

Leak Detector. New 8-page Bulletin GEC-233F describes maker's portable instrument for locating leaks in closed systems.—General Electric Co., Schenectady 5, N. Y.

Circle **458** on inquiry card.

Gas Pressure Switch. New 2-page Specification Sheet S1011-1 describes maker's industrial gas pressure switch.—Minneapolis-Honeywell Regulator Co., Ind. Div., Phila. 44, Pa.

Circle **459** on inquiry card.

Vacuum Breaker. New 8-page Bulletin 200 presents controlled-closing air valve for protection of pipe lines against surges and built-up pressures or water hammer.—Simplex Valve & Meter Co., Lancaster, Pa.

Circle **460** on inquiry card.

Manometers. New 1-page Catalog page 105 describes well type manometers for pressure, vacuum, and differential pressure.—The Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.

Circle **461** on inquiry card.

Vacuum Pump. New 2-page Data Sheet 2-71 presents maker's electric-motor driven, oil-wetted, ground-test

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vacuum pump.—Lear, Inc., Lear-Romec Div., Elyria, Ohio.
Circle **462** on inquiry card.

Pressure, Acceleration, Telemetering. New 2-page bulletin presents maker's transducers for pressure and acceleration, cathode followers, telemetering amplifiers and power supplies.—Endevco Corp., 161 E. California St., Pasadena, Calif.
Circle **463** on inquiry card.

Weigh-Feeding. New 2-page bulletin presents maker's automatic weigh-feeding unit for handling large quantities of dry materials.—Glengarry Processes, Inc., Bay Shore, N. Y.
Circle **464** on inquiry card.

Weight Recording. New 8-page Bulletin 2975 presents maker's equipment that scans weight graduations 120 times a minute at the scale, and remote records with tabulators, tape punches, or typewriters.—Toledo 1, Ohio.
Circle **465** on inquiry card.

Force Gage. New 6-page Bulletin 11E illustrates applications for maker's mechanical force gage used for measuring pressure, tension or torque.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.
Circle **466** on inquiry card.

FLOW

Armored Rotameters. New 12-page Bulletin 130 presents maker's armored rotameters for high-pressure-and-temperature, fluid-flow rate measurement and control.—Brooks Rotameter Co., Lansdale, Pa.
Circle **467** on inquiry card.

Flowmeters. New 16-page Catalog 10-A-25 describes maker's new glass-tube variable-area "Flowrator" meters.—Fischer & Porter Co., 692 Jacksonville Rd., Hatboro, Pa.
Circle **468** on inquiry card.

Positive Displacement Meter. New 12-page Bulletin FL-56 describes "Fluidometer," an automatic batching meter.—Hetherington & Berner Inc., 701 Kentucky Ave., Indianapolis 7, Ind.
Circle **469** on inquiry card.

Data Transmission. New 16-page Bulletin 700 describes maker's "Orthoflow" system for electrical transmission of flow, liquid level and pressure data.—Simplex Valve & Meter Co., 7 E. Orange St., Lancaster, Pa.
Circle **470** on inquiry card.

Flow Transducer. New 3-page bulletin describes Mark V turbine-type flow transducer that has no packings.—Ramapo Instrument Co. Inc., One Dey Lane, Riverdale, N. J.
Circle **471** on inquiry card.

PUMPS

Chemical Pumping. New 4-page Bulletin 1050 presents performance curves for maker's pumps for pumping corrosive, toxic and radioactive fluids at heads to 190 ft. and capacities to 200gpm.—Chempump Corp., Station M, 1300 E. Mermaid Lane, Phila. 18, Pa.

Circle **472** on inquiry card.

Rotary Pumps. New 4-page Bulletin AC56 presents line of "All-Chem" rotary displacement pumps for corrosive and hazardous fluids.—Eco Engineering Co., 12 New York Ave., Newark, N. J.

Circle **473** on inquiry card.

Hydraulic Pump. New 2-page Data Sheet 5-47 describes maker's 3 gpm, 4500 rpm, 1000 psi, rotary gear, positive-displacement oil pump for aircraft.—Lear, Inc., Lear-Romec Div., Elyria, Ohio.

Circle **474** on inquiry card.

NOISE, VIBRATION

Noise. New 16-page Book 0903-2 contains questions and answers on the problem of industrial noise. New 4-page Bulletin 0818-1 describes maker's 'Sounscope," a new sound level meter and analyzer. New 4-page Bulletin 0903-1 presents maker's over-the-ear protection devices.—Mine Safety Appliance Co., 201 N. Braddock Ave., Pgh. 8, Pa.

Circle **475** on inquiry card.

Vibration Mounts. New 8-page Bulletin 1000 describes latest developments in industrial shock and vibration mountings.—Robinson Aviation, Inc., Teterboro, N. J.

Circle **476** on inquiry card.

Vibration Damping. New 4-page Bulletin 33 describes use of beryllium copper in new vibration damping device for mounting electronic components.—The Beryllium Corp., Reading, Pa.

Circle **477** on inquiry card.

NUCLEONICS

Nuclear Instruments. New 4-page bulletin describes radioactivity ratemeter, survey meter, ore assayer, etc. —Anton Electronic Labs., Inc.. 1226 Flushing Ave., Brooklyn 37, N. Y.

Circle **478** on inquiry card.

Beta-Gamma Monitor. New 2-page bulletin describes CS-40 "Cutie Pie" beta-gamma monitor.—NRD Instrument Co., 6425 Etzel Ave., St. Louis 14, Mo.

Circle **479** on inquiry card.

Scintillation Counter. New 2-page bulletin presents maker's "Model CS-600" scintillation counter.—NRD Instrument Co., 6425 Etzel Ave., St. Louis 14, Mo.

Circle **480** on inquiry card.

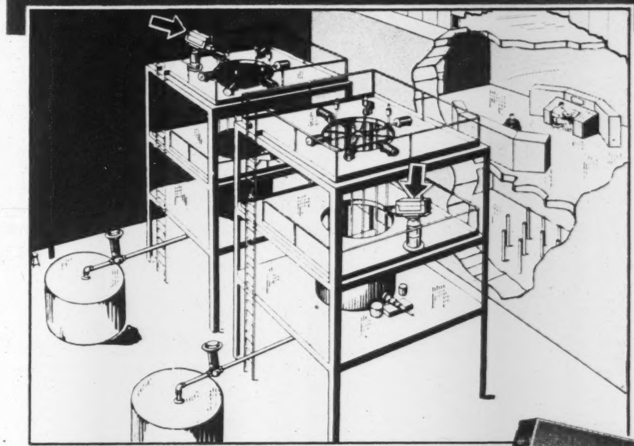
Rate Meter. New 2-page bulletin describes logarithmic rate meter with a range from 1 to 10,000 cps. New 4-page bulletin describes automatic single-channel analyzer for pulse analysis.—Devtron Engineering, One Winslow St., Redwood City, Calif.

Circle **481** on inquiry card.

COUNT

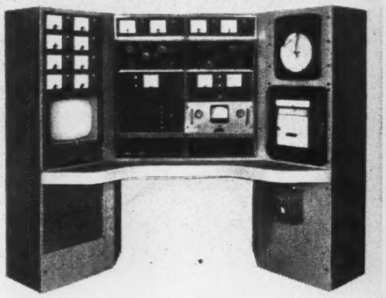
Counters. New 8-page Catalog M 200 describes maker's stroke and revolution counters with count life rat-

Diamond "UtiliVue"
(WIRED TELEVISION)
used in NUCLEAR REACTOR STUDIES
at Battelle Memorial Institute



Arrows indicate remotely controlled "UtiliVue" Cameras that SEE experimental nuclear reactor cores.

"UtiliVue" pedestal enables camera to be rotated 320° and tilted 90° by remote control from console. Zoom lens (also controlled from console) brings objects into focus at widely varying distances from camera.



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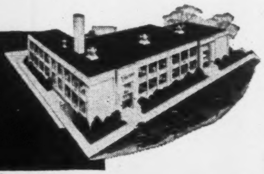

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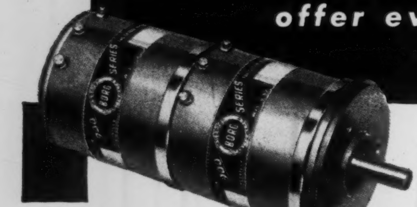

1. Versatility — 1 to 5 gang models, single or double shaft, servo or bushing mount.
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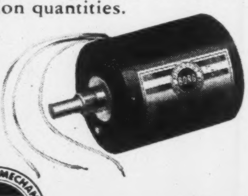

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ings to three million.—Production Instrument Co., 710 W. Jackson Blvd., Chicago 6, Ill.

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SPEED

Tachometers. New 6-page Bulletin 105 presents maker's stationary tachometers, takeoff heads, speed controls and recorders.—Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

Circle **483** on inquiry card.

COMPUTING

Analog Computers. New 14-page brochure presents components and applications for maker's electronic analog computers.—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Circle **484** on inquiry card.

Digital Computers. New 8-page illustrated brochure describes "ALWAC III-E" electronic digital computers. —Logistics Research, Inc., 141 So. Pacific Ave., Redono Beach, Calif.

Circle **485** on inquiry card.

Magnetic Shift Registers. New Engineering Bulletin 550-C describes maker's magnetic shift registers used in digital computer applications operating at frequencies of 30, 100, and 200 kc.—Sprague Electric Co., 401 Marshall St., N. Adams, Mass.

Circle **486** on inquiry card.

Computer Service. New 18-page leaflet 'One Source" presents information on maker's facilities for computer service, comprising both analog and digital equipments for simulation, computing, data reduction and data processing.—J. B. Rea Co., Inc., Santa Monica, Calif.

Circle **487** on inquiry card.

Angular Position Encoders. New 8-page Bulletin 0156 describes new 13-digit and 16-digit optical-type analog-to-digital angular-position encoders.—Electronics Div., Baldwin Piano Co., 1818 Gilbert Ave., Cincinnati 2, Ohio.

Circle **488** on inquiry card.

Computer Sub-Systems. New 2-page bulletins present self-contained, high-speed, dc analog computer subsystems requiring 60 cps line power only. Presented are a multiplier servo, resolver servo, electromechanical integrator and course generator. —Servonics, Inc., 834 N. Henry St., Alexandria, Va.

Circle **489** on inquiry card.

Magnetic Cores. New 4-page bulletin presents characteristics and applications of maker's tape-wound magnetic bobbin cores.—Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Phila. 7, Pa.

Circle **490** on inquiry card.

Recording Tape. New 4-page Bulletin T112A presents characteristics and properties of maker's magnetic recording tape for telemetering and computer applications.—Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y.

Circle **491** on inquiry card.

Tape Handler. New 4-page Bulletin 11553APH describes maker's "Tape-Minder" for handling tapes—teletype, ticker, automatic typewriter, etc.—Cycle Equipment Co., 420 Market St., San Francisco 11, Calif.

Circle **492** on inquiry card.

RECORDING

Automatic Oscillograph. New 16-page Bulletin GED-3049 describes new 22-channel automatic oscillograph for monitoring power system transmission circuits.—General Electric Co., Schenactady 5, N. Y.

Circle **493** on inquiry card.

Oscillograph. New 6-page Bulletin Sh 3731 presents multi-element recording oscillograph with electrical triggering and remote control provisions.—Siemens & Halske, Siemens New York Inc., 350 Fifth Ave., New York 1, N. Y.

Circle **494** on inquiry card.

Oscillograph. New 2-page Bulletin S-313 describes maker's recording oscillograph with three-speed paper control (6.6, 13 and 32.4 inches/sec).—Houston Technical Labs., 2424 Branard, Houston 6, Texas.

Circle **495** on inquiry card.

Electrophotographic Oscillograph. New 2-page Bulletin CGC-311 presents new-principle electrophotographic recording oscillograph, with 24-channel galvanometer light-beam recording and daylight loading.—Century Electronics & Instruments, Inc., 1333 N. Utica, Tulsa, Oklahoma.

Circle **496** on inquiry card.

Strip-Chart Recorder. New 2-page Bulletin INS-1206 describes maker's recorder using null-balancing potentiometer principle for recording dc signals with 100 millivolt span (10mv optional).—Varian Associates, Instrument Div., 611 Hansen Way, Palo Alto, Calif.

Circle **497** on inquiry card.

Operations Recorders. New 2-page Bulletin MG describes maker's timers with a speed range from one minute to one month. New 2-page Bulletin MD-Jr.-56 describes portable on-off operations recorder for recording when machines are operating.—Gorrell & Gorrell, Haworth, N. J.

Circle **498** on inquiry card.

Magnetic Tapes. New 12-page Brochure M-PMP describes properties of maker's "Scotch" brand magnetic tapes and films.—Minnesota Mining and Manufacturing Co., St. Paul, Minn.

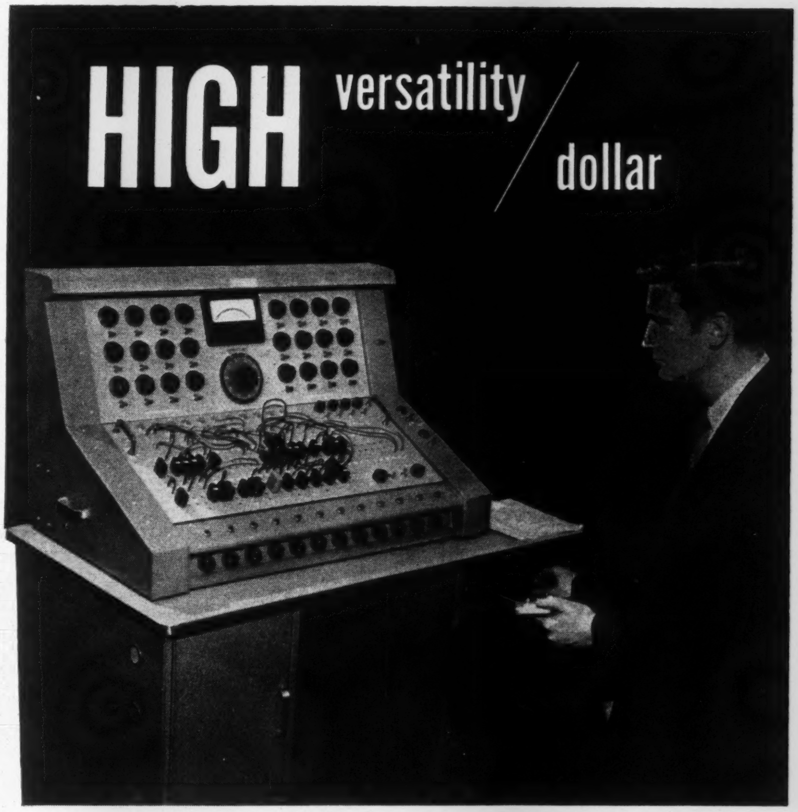
Circle **499** on inquiry card.

Magnetic-Tape Shielding. New 4-page Bulletin 103 describes how to protect tape recordings from magnetic fields by protective cans.—Magnetic Shield Div., Perfection Mica Co., 20 N. Wacker Dr., Chicago 6, Ill.

Circle **500** on inquiry card.

OPTICAL

Cameras. Two 8-page brochures presents technical data and operating characteristics on maker's "Traid" 71.35mm and "Automax" 35-mm cine-



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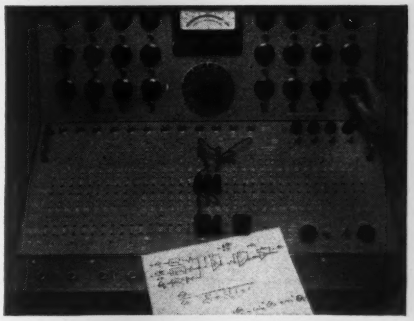

Simplicity of programming is seen in this second order system found in electrical (LRC) and mechanical (mass-spring damping) problems, using three amplifiers and plug-ins. Utilizing special second order plug-in further simplifies programming to a single amplifier.

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NEW LITERATURE

interval cameras.—Traid Corp., 4515 Sepulveda Blvd., Sherman Oaks, Calif.
Circle **501** on inquiry card.

Readers and Magnifiers. New 6-page bulletin presents maker's round, rectangular, pocket and desk magnifiers and reading glasses.—Apex Optical Corp., 50 Valley St., Providence, R.I.
Circle **502** on inquiry card.

SURFACE

Surface Roughness. New 2-page Catalog Sheet ED11701 presents specs on maker's "Surfindicator" for measuring surface roughness. New Catalog Sheet ED11704 describes accessories for "Surfindicator".—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.
Circle **503** on inquiry card.

Surface Roughness. New 14-page Catalog 156 covers surface roughness measuring equipment for: manual operation, straight-line mechanical tracing, circular tracing, etc.—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.
Circle **504** on inquiry card.

DIMENSIONAL GAGING

Thickness Gage. New 4-page Bulletin GEA-6458 describes maker's new hand-held, permanent-magnet thickness gage for measuring thickness of paint or other nonmagnetic materials.—General Electric Co., Schenectady 5, N. Y.
Circle **505** on inquiry card.

Optical Flats. New 6-page Bulletin 356 describes maker's line of shop and lab optical flats and monochromatic lamps. Bulletin 456-54 offers rehabilitation service of worn optical flats.—Acme Scientific Co., 1450 W. Randolph St., Chicago 7, Ill.
Circle **506** on inquiry card.

Electric Comparator. New 4-page Bulletin 200 describes maker's electric comparator for external measurements.—Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.
Circle **507** on inquiry card.

Gaging Systems. New 28-page Catalog 56 AM "Automation Gaging Systems and Standardized Control Units" describes four gaging systems for automatic control; electric, air-electric, electronic and air-electronic.—Federal Products Corp., 1144 Eddy St., Providence 1, R. I.
Circle **508** on inquiry card.

Air Gaging. New 4-page bulletin describes automatic, semi-automatic and manual air gaging applications for maker's air gaging equipment.—The Taft-Peirce Mfg. Co., Woonsocket, R. I.
Circle **509** on inquiry card.

Comparator. New 4-page bulletin presents maker's measuring comparator with 1 mm pitch screw provided with a graduated dial permitting readings to 1/1000 of a revolution, allowing readings to a fraction of a micron.—Paul M. McPherson, Acton, Mass.
Circle **510** on inquiry card.

ENVIRONMENTAL TEST

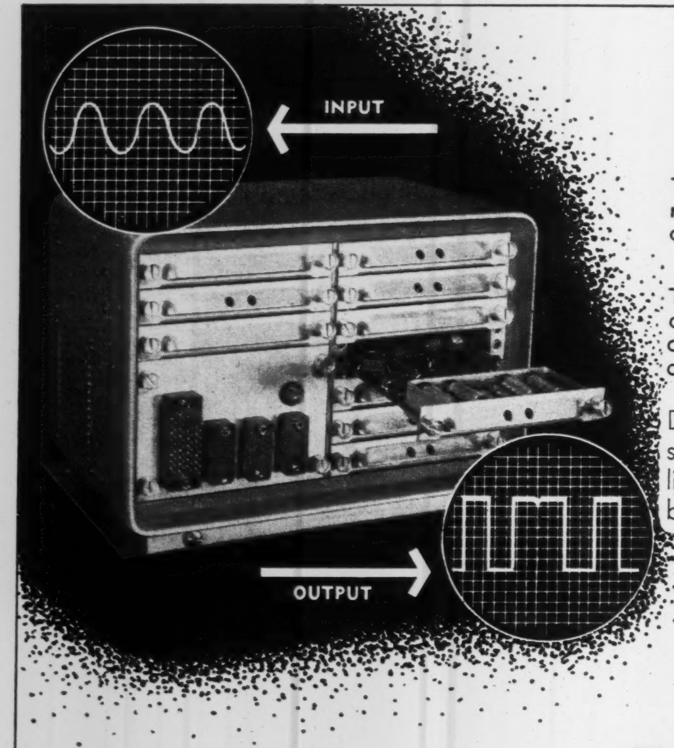
Environmental Test. New 16-page brochure describes maker's environmental test equipment including low temperature, high temperature, humidity (separate and combined units), altitude simulation and brine chambers.—Murphy & Miller, 1326 S. Michigan Ave., Chicago, Ill.
Circle **511** on inquiry card.

Temperature Test Chamber. New 6-page bulletin presents specs on maker's portable temperature test chamber.—Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.
Circle **512** on inquiry card.

Explosion Chambers. New 4-page bulletin describes maker's explosion chambers and test procedure used to simulate explosions of various magnitudes and pressures from sea level to 80,000 ft.—Tenney Engineering, Inc., 1090 Springfield Road, Union, N. J.
Circle **513** on inquiry card.

Environmental Test Service. New 8-page brochure describes extensive facilities for complete environment and performance test.—Rototest Labs., Inc., 2803 Los Flores Blvd., Lynwood, Calif.
Circle **514** on inquiry card.

Hardness Testing. New 12-page Bulletin DH-328 describes maker's micro and macro hardness testers for metallic and non-metallic parts such as fine wire, small precision



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DIGITAL ENCODER

This encoder is an all electronic piece of equipment capable of digitizing 24,000 8-bit binary code groups per second.

The Coder's all electronic circuitry which includes solid state components mounted on etched circuit, plug-in, cards provides for increased operational reliability and ease of maintenance.

Designed to operate in either air or ground systems, the coder's compact construction and light weight substantially reduces the need for bulky equipment in data handling systems.

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Accuracy: One Part in 256
Power Requirements: 100 watts
Signal Input Impedance: 100 K ohms
Operating Temperature Range: -55°C to + 71°C
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Weight: 8 pounds

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parts, thin metal, superficially hardened surfaces, jewels, plastics, glass, etc.—Wilson Mech. Instr. Div., American Chain & Cable Co., Inc., 929 Conn. Ave., Bridgeport 2, Conn.
Circle **515** on inquiry card.

Test Instruments. New 4-page Leaflet P-560 presents 31 instruments for testing paper, plastics, textiles, light metals, etc.—Thwing-Albert Instrument Co., Penn St. at Pulaski Ave., Philadelphia 44, Pa.
Circle **516** on inquiry card.

GEOPHYSICAL

Geophysical Instruments. New 2-page Bulletin E-401 presents new portable instruments for electrical-resistivity method geophysical prospecting.—Houston Technical Labs., 2424 Branard, Houston 6, Texas.
Circle **517** on inquiry card.

Seismic Blaster. New 2-page Bulletin S-315 describes new seismic short-pulse blaster with application time break inaccuracy confined to 0.5 millisecond.—Houston Technical Labs., 2424 Branard, Houston 6, Texas.
Circle **518** on inquiry card.

FURNACES

Snap Hearth Furnace. New 4-page Bulletin SC-173-4 describes maker's new snap hearth furnace with radiant tubes for controlled atmosphere heat treating and quenching.—Surface Combustion Corp., Toledo 1, Ohio.
Circle **519** on inquiry card.

Industrial Furnaces. New 18-page catalog describes maker's standard and special furnace to 3000°F and ovens.—L & L Mfg. Co., 136 8 St., Upland, Chester 73, Pa.
Circle **520** on inquiry card.

Ovens. New 2-page bulletin presents maker's ovens for drying finishes, moisture, preheating, etc.—Drying Systems, Inc., 1800 Foster Ave., Chicago 40, Ill.
Circle **521** on inquiry card.

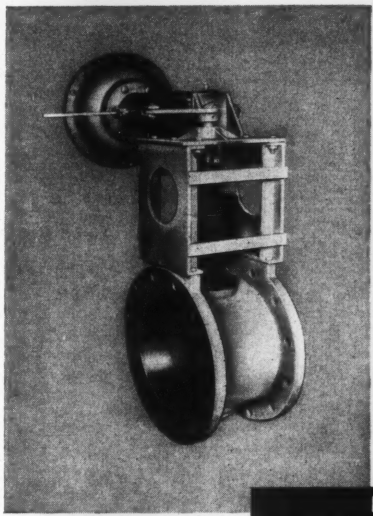
LABORATORY

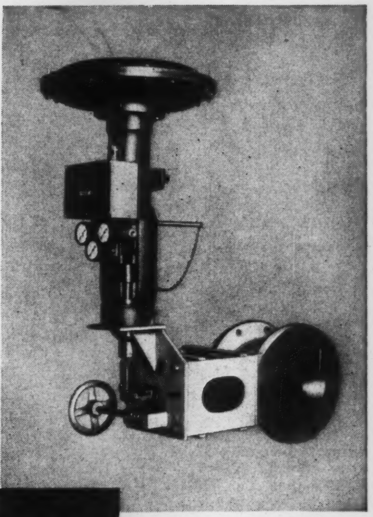
Glass Apparatus. New 18-page catalog describes maker's new line of "Bantam Ware" small organic glass apparatus with ball and socket joints. —Kontes Glass Co., Vineland, N. J.
Circle **522** on inquiry card.

Sieves, Penetrometer. New 4-page bulletin presents sieves, sieve shakers and sample splitters. New 2-page bulletin presents maker's new pocket penetrometer for classification of soils.—Soiltest Inc., 4711 W. North Ave., Chicago 39, Ill.
Circle **523** on inquiry card.

Balances. New 6-page bulletin presents maker's line of single and double beam balances.—Ohaus Scale Corp., Union, N. J.
Circle **524** on inquiry card.

Polyethylene Lab Ware. New 6-page Supplement 563 presents pumps, trays, jars, bottles, and laboratory ware made from inert polyethylene. —Bel Art Products, 4917 Murphy Place, W. New York, N. J.
Circle **525** on inquiry card.





R-S
BUTTERFLY VALVES

Special 12-inch R-S Butterfly Valve, with finned lubricated stuffing box, for service with hot gases at 1,000° F.

6-inch, raised-face R-S Butterfly Valve for elevated temperatures.

SPECIAL R-S VALVES SOLVE TEMPERATURE, CORROSION, ABRASION PROBLEMS

To meet rugged processing conditions, R-S Butterfly Valves can be built to your requirements. For valve bodies and parts, any metal or other material that can be cast or welded — even plastics — may be specified.

There are a number of materials available to meet extreme working conditions involving corrosion, abrasion, erosion, high heat and pressure. In addition, the R-S Rubber-lined Valve may be specified to resist certain types of corrosion. Every R-S Valve gives you quick and positive closure with any type of controls, uniform control in normal regulating ranges and minimum pressure drop.

If your past experience offers no precedent, you can call on our background in specialized valve engineering to solve material problems.

We have built valves to operate in a temperature range of from −300° F to +2,000° F. For complete information on our complete line of butterfly, ball and cone valves, see our local representative or write S. Morgan Smith Company, York, Pennsylvania.

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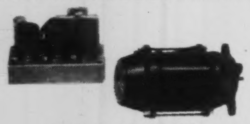
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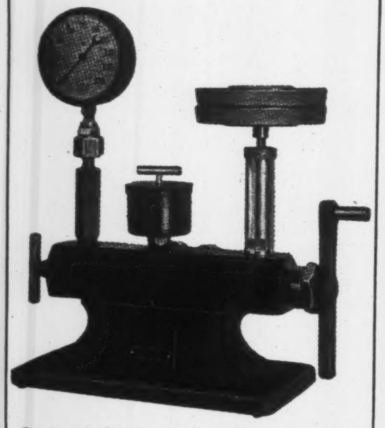

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NEW LITERATURE

Refrigerated Incubators. New 4-page Circular 1267 presents maker's refrigerated incubators for constant temperatures from 5 to 50°C.—Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill.

Circle **526** on inquiry card.

Lab Equipment. New 8-page general catalog describes maker's line of centrifuges, ultra-microtomes, automatic pipettes, conductivity bridge, electrophoresis and chromatography equipment, gas and moisture testers. —Ivan Sorvall, Inc., Pearl St., Norwalk, Conn.

Circle **527** on inquiry card.

Laboratory Furniture. New 16-page Catalog W-3 presents maker's line of interchangeable, sectional units and includes graphic visualizer kit for laying out a laboratory.—Laboratory Furniture Co., Inc., Mineola, N.Y.

Circle **528** on inquiry card.

ANALYTICAL

pH and Conductivity. New 20-page Catalog 1551 describes maker's pH and conductivity recorders and controllers. Includes principles and equipments. —Minneapolis-Honeywell Regulator Co., Ind. Div., Phila. 44, Pa.

Circle **529** on inquiry card.

Recording Turbidimeter. New 4-page Bulletin GEC-1203A presents maker's recording turbidimeter for continuous measurement and recording of suspended matter in liquids.—General Electric Co., Schenectady 5, N. Y.

Circle **530** on inquiry card.

Gas Analyzers. New 4-page Data Sheet 10.15-4b describes Davis combustible gas analyzers with Brown ElectroniK recorders and controllers. —Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **531** on inquiry card.

Spectrophotometer Accessory. New 2-page Bulletin A-8 presents accessory mechanism for Model 21 spectrophotometer that allows direct recording of linear absorbance over the range 0 to 1.0 absorbance unit.—Perkin-Elmer, Norwalk, Conn.

Circle **532** on inquiry card.

Infrared Instruments. New 8-page catalog describes maker's infrared radiometers, infrared detectors, refractometers, infrared sources and detector preamplifiers.—Barnes Engineering Co., 30 Commerce Road, Stamford, Conn.

Circle **533** on inquiry card.

Industrial Spectrograph. New 8-page Catalog SL-456 presents maker's "Spec-Lab" low-cost, high-precision industrial spectrograph.—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Circle **534** on inquiry card.

Spectrophotometer Accessories. New 2-page Bulletin 479 presents maker's accessories for converting field instruments to linear wavelength recording, flame emission recording, etc.—Beckman Instruments, Inc., Fullerton, Calif.

Circle **535** on inquiry card.

X-Ray Diffractometer. New 4-page bulletin describes double-crystal X-ray diffractometer for metallurgical studies, etc.—New Brunswick Scientific Co., P.O. Box 606, New Brunswick, N. J.

Circle **536** on inquiry card.

Oxygen Meter. New 4-page Bulletin Sh 3353 presents magnetic gas analyzer to determine combustion efficiency.—Siemens & Halske, Siemens New York Inc., 350 Fifth Ave., New York 1, N. Y.

Circle **537** on inquiry card.

Infrared Spectrophotometer. New 4-page Bulletin 472-A describes performance and features of maker's infrared spectrophotometer.—Beckman Instruments, Inc., Fullerton, Calif.

Circle **538** on inquiry card.

Atmosphere Analyzer. New 2-page bulletin describes maker's instrument for recording concentrations of pollutants in the atmosphere, including ozone, nitrogen dioxide, nitric oxide and sulfur dioxide.—Harold Kruger Instruments, P.O. Box 164, San Gabriel, Calif.

Circle **539** on inquiry card.

H_2S Detector. New 4-page Bulletin 0805-1 presents maker's hand-operated detector for H_2S concentrations.—Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa.

Circle **540** on inquiry card.

Spectrographic Analysis. New 6-page bulletin presents maker's "Spec-Trol" equipment for the spectrochemical laboratory.—National Spectrographic Labs., Inc., 6300 Euclid Ave., Cleveland 3, Ohio.

Circle **541** on inquiry card.

Recording Titrometer. New 8-page Bulletin 640B presents maker's automatic feed recording titrometer.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **542** on inquiry card.

Chromatography and Electrophoresis. New 20-page illustrated brochure describes maker's chromatographic cabinets, electric desalters, paper electrophoresis apparatus, etc.—Harshaw Scientific Div. of Harshaw Scientific Div. of Harshaw Chemical Co., 1945 E. 97th St., Cleveland 6, Ohio.

Circle **543** on inquiry card.

Chromatography and Electrophoresis. New 36-page Catalog C-465 presents apparatus for chromatography and electrophoresis.—Scientific Glass Apparatus Co., Inc., Bloomfield, N.J.

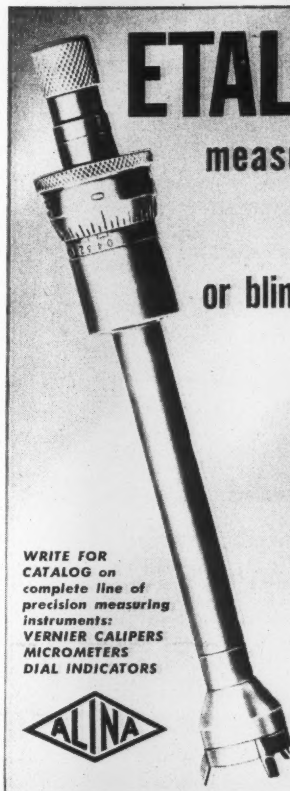
Circle **544** on inquiry card.

N-M-R Spectroscopy. New 4-page Bulletin INS-1208 discusses NMR chemical shifts in oxygen and nitrogen compounds.—Varian Assocs., Palo Alto, Calif.

Circle **545** on inquiry card.

Ultraviolet Monochromator. New 4-page brochure describes maker's one-meter, scanning, vacuum, ultraviolet monochromator.—Paul M. McPherson, Acton, Mass.

Circle **546** on inquiry card.



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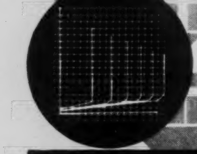

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NEW LITERATURE

Spectrograph. New 2-page bulletin describes maker's X-ray spectrograph used at the Martinez Refinery.—North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

Circle **547** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Electronic Test Instruments. New 20-page Catalog Supplement 22-A includes maker's line of oscilloscopes, counters, and improved standard instruments.—Hewlett-Packard Co., 170 E. 80 St., New York 21, N.Y.

Circle **548** on inquiry card.

Oscillography. New 4-page illustrated brochure describes maker's electronic systems for industry and research—oscilloscopes, phototubes, ITV systems, etc.—Allen B. DuMont Labs., Inc., 760 Bloomfield Ave., Clifton, N.J.

Circle **549** on inquiry card.

Panel Instruments. New 12-page Bulletin GEC-368H describes maker's 2 1/2", 3 1/2" and 4 1/2" panel instruments.— General Electric Co., Schenectady 5, N. Y.

Circle **550** on inquiry card.

Indicators, Recorders, Recording Controllers. New 2-page Bulletin GE C-1362A presents specs on maker's indicators, recorders and recording controllers.—General Electric Co., Schenectady 5, N.Y.

Circle **551** on inquiry card.

Pulse and Counting Equipment. New data sheets describes maker's square pulse generator, "Model 800 series" 0.1-microsecond counter chronographs, "Models 410 and 412" 10-Mc scalers, etc.—Electrical and Physical Instrument Corp., 25 West 43rd St., New York 36, N. Y.

Circle **552** on inquiry card.

Digital Instruments. New 28-page Catalog 356 describes digital type voltmeters, ohmmeters, readouts, data reduction systems, peak reader systems, recording systems. Also ac-dc converters and binary-decimal converters.—Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif.

Circle **553** on inquiry card.

Digital VTVM. New 2-page bulletin describes maker's digital VTVM with 1% accuracy, overload protection, and illuminated decimal point; and a rack-mounted VTVM with print-out facilities.—Hycon Electronics, Inc., 321 S. Arroyo Parkway, Pasadena, Calif.

Circle **554** on inquiry card.

Microvoltmeter. New 2-page bulletin presents maker's dc transistorized microvoltmeter with sensitivity of 1 uv.—Millivac Instrument Corp., P.O. Box 997, Schenectady, N.Y.

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Millisecond Meter. New 4-page bulletin describes millisecond meter for measuring short time intervals, time delays, on and off times, shutter open intervals, etc.—Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N.Y.

Circle **556** on inquiry card.

Milliammeter. New 2-page Catalog Sheet 1006 describes maker's volt-ohm-milliammeter with overload protection and signal light, 43 ranges and color-coded scales.—Phaostron Instr. and Electronic Co., 151 Pasadena Ave., S. Pasadena, Calif.
Circle **557** on inquiry card.

Resistance Tester New 4-page Bulletin 2C presents data on maker's "Vibrotest" for testing circuits, panels, switches, motors, circuit-breakers, cable and wiring.—Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.
Circle **558** on inquiry card.

Pre-Amplifiers. New 2-page Bulletin describes hushed transistor pre-amplifiers for dc and ac.—Volkers & Schaffer Mfg. Corp., Box 996, Schenectady, N. Y.
Circle **559** on inquiry card.

Multiple Ammeter, Moisture Meter. New 2-page bulletin presents maker's multiple ammeter for ac and standard resistors with accuracy of ±0.01%; also moisture meters for wood and wood products.—Physics Research Labs. Inc., 507 Hempstead Turnpike, W. Hempstead, N. Y.
Circle **560** on inquiry card.

Tube Testers. New 2-page bulletin presents maker's dynamic mutual conductance tube and transistor tester, life-performance tube and set tester, tube and battery tester and a lightweight, portable tube tester.— Radio City Products Co., Inc., Centre and Glendale St., Easton, Pa.
Circle **561** on inquiry card.

Voltage Tester. New 2-page bulletin describes adjustable high-voltage tester (up to 2500 v ac) with buzzer signal on breakdown, ground and shorts.—Slaughter Co., Piqua, Ohio.
Circle **562** on inquiry card.

VTVM. New 4-page leaflet presents data on maker's "Meter-Matic" automatic-range-switching vacuum-tube volt-ohm meter.—Leitch Engineering Corp., 326 Lincoln St., Manchester, N. H.
Circle **563** on inquiry card.

VTVM. New 4-page Catalog VM-106 describes maker's line of miniature, panel-mount, ac and dc vacuum-tube voltmeters.—Trio Labs., 3293 Seaford Ave., Wantagh, N. Y.
Circle **564** on inquiry card.

Pulse Delay Generator. New 4-page bulletin presents variable time-delay generator in increments of 0.1 microsecond.—Orbitran Co., P.O. Box 635, Lakeside, Calif.
Circle **565** on inquiry card.

Phase Comparator. New 6-page Bulletin LP 3525 describes operation and applications of maker's phase comparator for computer, control and servomechanism testing.—Link Aviation, Inc., Binghamton, N. Y.
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POWER SUPPLIES

Power Supplies New 6-page Bulletin S-56 presents specifications on maker's standard tubeless magnetic-amplifier-regulated supplies for 6, 12, 28 and 115 volts dc.—Perkin Engineer-

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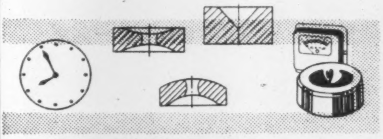

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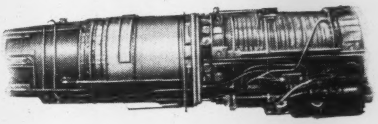

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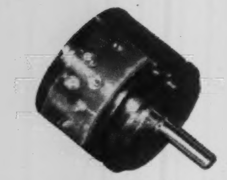

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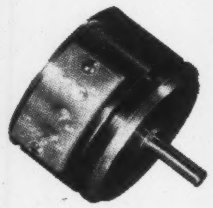

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MAP-2	60	15.	115	1.6	2.4
MAP-3	60	50.	115	2.0	0.5
MAP-3-1	60	50.	115	7.0	2.9
MAP-4	60	175.	115	8.0	6.0
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NEW LITERATURE

ing Corp., 345 Kansas St., El Segundo, Calif.
Circle **567** on inquiry card.

Voltage Regulators. New 2-page Data Sheet Y-1 presents three types of ac voltage regulators for 30-kw engine-driven alternators.—Arga Div., Beckman Instruments, Inc., S. Pasadena, Calif.
Circle **568** on inquiry card.

Power Supplies New 8-page Bulletin BF56-1 presents maker's line of regulated dc power supplies.—Universal Electronics Co., 1720 22 St., Santa Monica, Calif.
Circle **569** on inquiry card.

Power Supplies. New 6-page Supplement 3A presents specifications on maker's "Series 200 MA" dc power supplies.—Lambda Electronics Corp., 11-11 131st St., College Point 56, N.Y.
Circle **570** on inquiry card.

Power Supplies. New 4-page Brochure B356 presents condensed specs on maker's line of voltage regulated power supplies.—Kepco Labs., 131 Sanford Ave., Flushing 55, N. Y.
Circle **571** on inquiry card.

Power Supplies. New 2-page Catalog PR156 presents specs, ratings and prices on maker's dc power supplies, dc power components, selenium rectifiers, chokes and transformers.—Technical Apparatus Builders, 109 Liberty St., New York 6, N. Y.
Circle **572** on inquiry card.

Power Supply. New 2-page bulletin F-1471 presents maker's new mobile fixed power supply that operates from 6 or 12 v battery or 117 v ac line to power both transmitter and receiver.—James Vibrapowr Co., Chicago, Ill.
Circle **573** on inquiry card.

PRINTED CIRCUITS

Printed Circuit Tolerances. New 2-page Bulletin P-9 discusses "Standard Printed Circuit Tolerances".—Photocircuits Corp., Engineering Dept., Glen Cove, N. Y.
Circle **574** on inquiry card.

Printed Circuit Layouts. New 2-page Bulletin 163-B presents maker's self-sticking, pre-cut terminal circles and connector strips for printed circuit master layouts.—W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.
Circle **575** on inquiry card.

Printed Circuitry. New 4-page bulletin describes maker's printed circuitry process, including steps necessary for circuit duplication.—Croname Inc., 3701 Ravenswood Ave., Chicago 13, Ill.
Circle **576** on inquiry card.

RESISTORS, POTENTIOMETERS

Potentiometers. New 12-page illustrated Brochure 608-207 presents specifications on maker's rotary, rectilinear, sector potentiometers.—General Controls, 801 Allen Ave., Glendale 1, Calif.
Circle **577** on inquiry card.

Wirewound Resistors. New 4-page Bulletin D-la presents data on mil type precision wirewound resistors.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.
Circle **578** on inquiry card.

Power Rheostats. New 2-page issue of "The Ohmite News" (Jan., '56) features maker's power rheostats, including 24 resistance values in ten sizes of rheostats.—Ohmite Mfg. Co., 3603 Howard St., Skokie, Ill.
Circle **579** on inquiry card.

ELECTRICAL CONNECTORS

Connectors. New 14-page Catalog R2 presents ratings for maker's line of rack and panel connectors, including standard, miniature and circular types, pin and socket connectors, and printed circuit connectors.—American Phenolic Corp., 1830 S. 54 Ave., Chicago 50, Ill.
Circle **580** on inquiry card.

Receptacles and Plugs. New 8-page Bulletin 238 describes "Flexlub" socket and pin receptacles, socket and pin plugs, and binding posts.—The Standard Electric Time Co., Springfield 2, Mass.
Circle **581** on inquiry card.

Connectors. New 8-page Bulletin D-6 describes maker's line of subminiature connectors.—Cannon Electric Catalog Dept., 3208 Humboldt St., Los Angeles 31, Calif.
Circle **582** on inquiry card.

Connectors. New 4-page bulletin decribes maker's miniature connector series for rack and panel equipment. —Gorn Electric Co., Inc., Stamford, Conn.
Circle **583** on inquiry card.

Connectors. New 2-page Bulletin 46C presents for maker's high-voltage pressurized connectors.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.
Circle **584** on inquiry card.

Connectors. New 4-page bulletin describes maker's connectors and new connector designs.—Alden Products Co., Brockton, Mass.
Circle **585** on inquiry card.

RELAYS, SWITCHES

Automatic Transfer Switches. New 16-page Bulletin 596 discusses ten features required for adequate design of automatic transfer switches, including inrush current capacity, continuous duty rating, ability to transfer rapidly and interrupt arc instantaneously, etc.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.
Circle **586** on inquiry card.

Circuit Selectors. New 12-page Bulletin 456 CSR describes circuit selectors and stepping relays with forward drive, reverse drive and bi-directional. —G. H. Leland Inc., 123 Webster St., Dayton 2, Ohio.
Circle **587** on inquiry card.

Relay. New 2-page Bulletin 102 describes maker's shock-mounted, hermetically sealed, 4 oz relay of high

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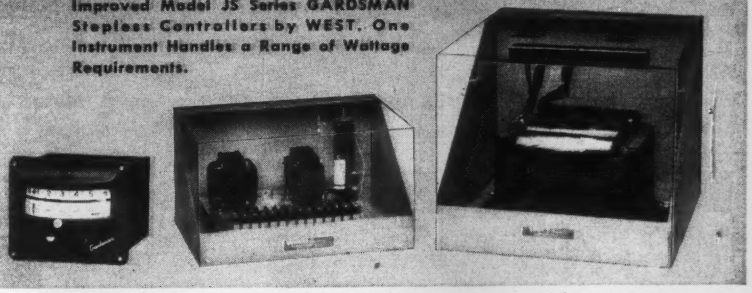

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NEW LITERATURE

sensitivity.—Assembly Products, Inc., Wilson Mills Rd., Chesterland, Ohio.
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Subminiature Switches. New 16-page Catalog 75a presents maker's line of 56 switches, auxiliary actuators and switch assemblies.—Micro Switch, Div. of Minneapolis-Honeywell Reg. Co., Freeport, Ill.
Circle **589** on inquiry card.

ELECTRONIC COMPONENTS

Silicon Rectifiers. New 2-page bulletins describe maker's silicon rectifiers for stable operation at temperatures to 150°C, with high breakdown voltage (1500v). Bulletin DL-615 presents a full-wave rectifier. Bulletin DL-S 617 presents a grown junction rectifier. Bulletin DL-S 618 presents a grown junction rectifier with stud mounting. Bulletin DL-S 614 presents silicon high conductance junction diodes.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas.
Circle **590** on inquiry card.

Microminiature Tubes. New 20-page bulletin ETD-1212-A describes maker's new microminiature metal-ceramic receiving tubes ⅜" long and $\frac{5}{16}$" diam. with power gain of 15 decibels and noise factor of 8.5 decibels. —General Electric Tube Dept., 1 River Rd., Schenectady 5, N. Y.
Circle **591** on inquiry card.

Plug-in Circuitry. New 4-page bulletin presents maker's plug-in components for electronic circuits.—Alden Products Co., 127 N. Main St., Brockton, Mass.
Circle **592** on inquiry card.

Semiconductor Production Control. New 26-page Bulletin SMEL #1 discusses "Control Systems for Semiconductor Crystal Production."—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.
Circle **593** on inquiry card.

Silicon Diodes. New 8-page issue of "Rectifier News" No. 356 features new silicon power diodes designed primarily for high temperature applications.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.
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Indicating Light. Two new 2-page bulletins describe maker's new 2-pin indicating lamp and lamp holders.—Drake Mfg. Co., 1713 W. Hubbard St., Chicago 22, Ill.
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Klystron. New 2-page bulletin presents maker's klystron for X-band radar receivers.—Varian Assocs., Palo Alto, Calif.
Circle **596** on inquiry card.

Metallized Components. New 4-page bulletin presents maker's waveguide resistance elements, disc resistors, high-vacuum coatings for optics, attenuator plates and coaxial resistance elements.—Metavac Inc., 45-68 162 St., Flushing 58, N. Y.
Circle **597** on inquiry card.

Electronic Parts. New 32-page Catalog T4-56 includes circuit kits, com-

ponents, transistors and parts.—Lafayette Radio, 100 Sixth Ave., New York 13, N. Y.
Circle **598** on inquiry card.

Photocells. New 4-page Bulletin 67-168 presents response and characteristics for maker's cadium-sulphide photoresistive elements.—Hupp Electronics Co., 743 Circle Ave., Forest Park, Ill.
Circle **599** on inquiry card.

Transistors, Semiconductor. New 4-page bulletins present maker's semiconductors. Bulletin TE1340 presents specs on silicon power rectifiers, transistors, germanium diodes and silicon diodes. Bulletins TE-1336 and TE-1336A present specs on military type silicon power rectifiers. 2-page Bulletin TE 1335 presents lead-mounted silicon rectifiers, and 2-page Bulletin TE 1338 presents miniature silicon rectifiers.—Transitron Electronic Corp., Melrose 76, Mass.
Circle **600** on inquiry card.

Inductive Potentiometer. New 2-page bulletin 11L/2S presents physical and electrical characteristics of maker's inductive potentiometer.—Transicoil Corp., Worcester, Pa.
Circle **601** on inquiry card.

Mica Capacitors. New 4-page Bulletin 422-4 presents specifications on high-temperature molded midget mica capacitors.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.
Circle **602** on inquiry card.

Electronic Parts. New 13-page brochure describes terminals, jacks, knobs and custom-molded products.—Whitso, Inc., 9330 Byron St., Schiller Park, Ill.
Circle **603** on inquiry card.

MECHANICAL COMPONENTS

Precision Gears. New 4-page bulletin illustrates maker's experience in engineering precision gears, gear sets and gear trains.—H. O. Boehme, Inc., 915 Broadway, New York 10, N. Y.
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Gear Train Design. New 8-page booklet discusses "Miniaturized Gear Train Design Simplified."—Washington Machine and Tool Works, Inc., 1001 Washington Ave. So., Minneapolis 15, Minn.
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Bearings. New 8-page set of data sheets illustrates applications for maker's "Versa Twin" double-row unground ball bearings.—Hartford Steel Ball Co., Inc., Station A, Hartford 6, Conn.
Circle **606** on inquiry card.

Screws. New 32-page Catalog 877 presents maker's line of socket and square-head set and cap screws.—Unbrako Socket Screw Div., Standard Pressed Steel Co., Jenkintown, Pa.
Circle **607** on inquiry card.

Carbide and Cemented Oxide Inserts. New 2-page Bulletin GT-311 presents specs for maker's new high titanium, nickel binder grade 330 finishing carbide. New 2-page Bulletin GTO-102 describes maker's cemented-

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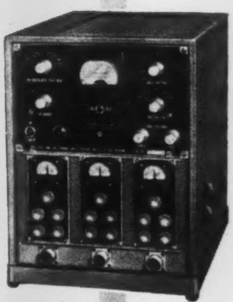

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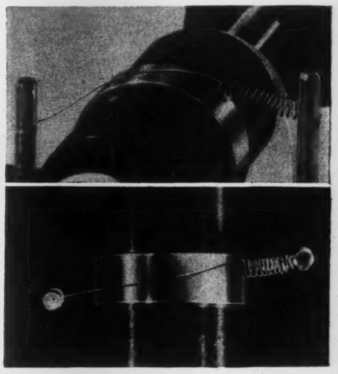

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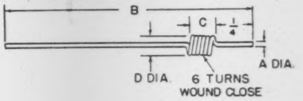

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oxide throw-away inserts.—Carboloy Dept., General Electric Co., Detroit 32, Mich.

Circle 608 on inquiry card.

TUBING, FITTINGS

Tubing Test Plugs. 2-page Bulletin 3057 describes maker's test plug kit (for temporarily shutting off tubing); also combination tube cutter and tube constrictor for sweating a larger tube to a smaller tube.—Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.

Circle 609 on inquiry card.

Instrument Tubing. New 4-page Bulletin 456 describes and specifies maker's copper, aluminum and polyethylene tubing, multiple-tube harnesses, etc.—Dekoron Products Div., Samuel Moore & Co., Mantua, Ohio.

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Nylon Tubing Fittings. New 3-page bulletins describe maker's nylon plastic fittings for flareless connecting of metal or plastic tubing; Bulletins 1100G and 1101G present specs on various models and sizes, Bulletin 1102G presents mechanical, thermal and chemical properties of the fittings.—Thomas Assoc., 4607 Alger St., Los Angeles 39, Calif.

Circle 611 on inquiry card.

AIR, STEAM

Air Dryers. New 2-page Bulletin 4562 presents description and data on regenerative dessicant dryers for large volumes of compressed air or gas.—Industrol Corp., 472 Westfield Ave., E. Roselle Park, N. J.

Circle 612 on inquiry card.

Humidity and Dew Point. New 2-page reprint "The Dew Point Story" explains dew point, relative humidity, and saturation point in non-technical language.—Hankison Corp., 193 Biltmore Bldg., Pgh. 16, Pa.

Circle 613 on inquiry card.

Space Filter. New 4-page Bulletin 1505-3 presents data on maker's Ultra-Aire space filter.—Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle 614 on inquiry card.

Dryers. New 4-page bulletin describes maker's equipment for drying gases by refrigeration.—Murphy & Miller, Inc., 1326 S. Michigan Ave., Chicago, Ill.

Circle 615 on inquiry card.

FABRICATION

Rhodium Electroplating. New 20-page Bulletin 4727 provides data and directions for electroplating with rhodium.—Baker & Co., Inc., 113 Asttor St., Newark 5, N. J.

Circle 616 on inquiry card.

Coil Winding Machines. New 82-page Catalog 56 describes maker's line of 42 coil winding machines and accessories that wind continuous resistance coils, deflection yokes, variable pitch, toroidal, armatures and field coils.—George Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 30, Ill.

Circle 617 on inquiry card.

Drafting Machine. New 2-page folder describes maker's "Draftette" that clamps to drawing board or sketch pad for accurate field drafting work.—David Miller & Assoc., P.O. Box 572, Beverly Hills, Calif.

Circle 618 on inquiry card.

Metal Stampings. New 8-page catalog presents data on maker's standard and custom-product stampings.—H. Braun Tool & Instrument Co., Inc., 140 Fifth Ave., Hawthorne, N. J.

Circle 619 on inquiry card.

MATERIALS

Solvent Cleaning. New 8-page bulletin presents maker's spray-cleaning technique and equipment.—Cobehn, Inc., Caldwell, N. J.

Circle 620 on inquiry card.

Fibre Components. New 14-page Catalog C-56 describes maker's synthetic-resin impregnated material available in sheets, molded-laminates, molded-macerated and combination laminated-macerated material.—Continental-Diamond Fibre, Newark, Del.

Circle 621 on inquiry card.

Packaging Material. New 8-page bulletin describes maker's "Hairflex" packaging material.—Armour Curled Hair Div., North Benton Rd., Alliance, Ohio.

Circle 622 on inquiry card.

Copper Alloys. New 8-page catalog describes methods used to heat treat maker's "Berylco" copper wrought and casting alloys.—Beryllium Corp., Reading, Pa.

Circle 623 on inquiry card.

Packaging. New 24-page Booklet No. 6 "How to Ship by Air in Corrugated Boxes" discusses international shipments, damage responsibility, carrier restrictions, load limitations, etc.—Hinde & Dauch, Sandusky, Ohio.

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Ceramics. New 4-page Bulletin 563 presents mechanical and electrical properties of maker's ceramics.—American Lava Corp., Chattanooga 5, Tenn.

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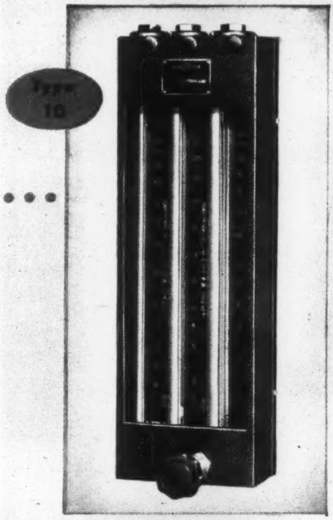

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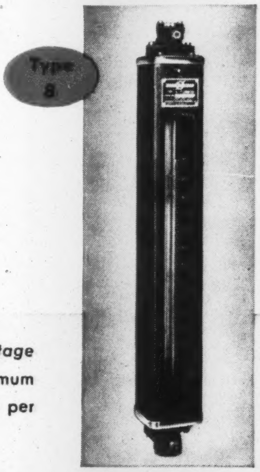

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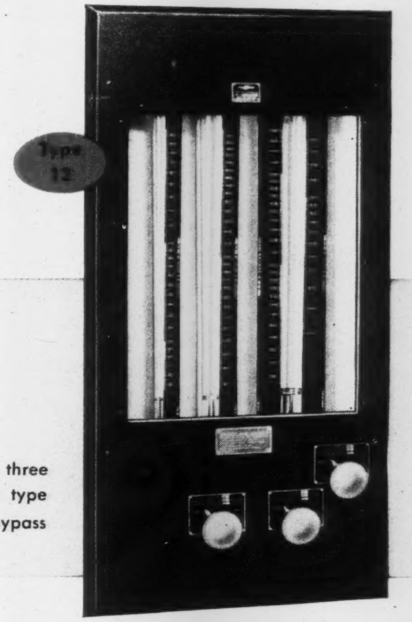

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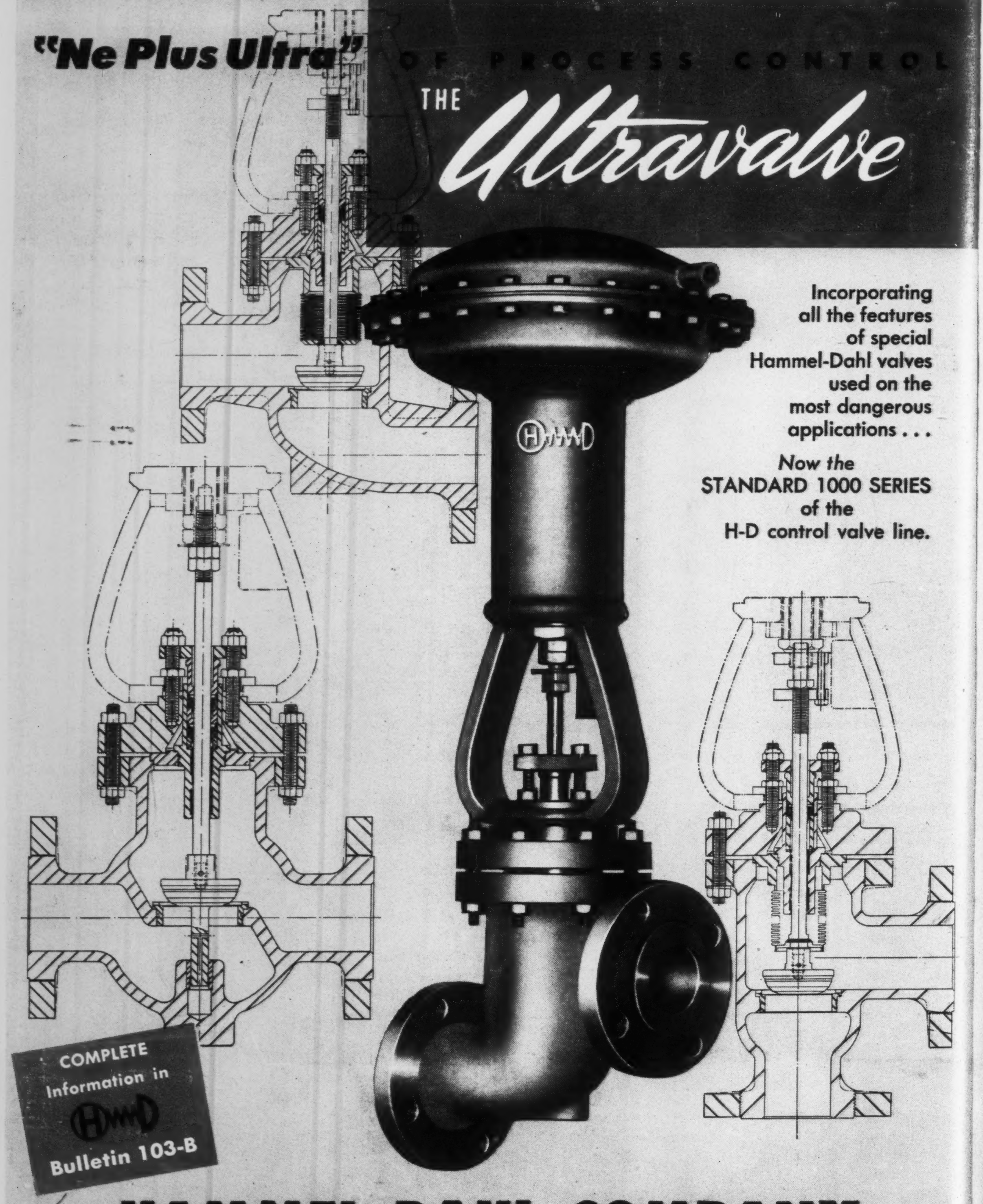

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